REPORT

—OF—

THE BOARD OF SEWERAGE

—OF—

THE TOWN OF MORRISTOWN, N. J.

WITH

THE REPORT OF THE ENGINEERS

MAPS, PLANS, ESTIMATES, ETC.

PRESENTED

FEBRUARY 28, 1907

"The Jerseyman" Press, Morristown, N. J.

BOARD OF ALDERMEN

MAYOR:

ALEXANDER BENNELL

ALDERMEN:

JACOB O. ARNOLD
OLIVER K. DAY
WALTER V. MESLER
IRA MOWERY
JOHN J. A. OWENS
CLIFFORD RUTAN
J. DIXON THOMPSON
KINSLEY TWINING

BOARD OF SEWERAGE

PHILIP H. COOPER, Chairman
EUGENE S. BURKE, Secretary
CHARLES D. M. COLE
EMILE HURTZIG

ENGINEERS

WILLIAMS, PROCTOR & POTTS

NEW YORK CITY

REPORT OF BOARD OF SEWERAGE

To The Honorable The Mayor And Board of Aldermen of The Town of Morristown.

Gentlemen :

The Board of Sewerage of the Town of Morristown, appointed by His Honor, Abram Q Garretson, Judge of the Circuit Court of the County of Morris, under and by virtue of an act of the Legislature of the State of New Jersey, entitled "An Act to authorize incorporated towns to construct, operate and maintain a system of sewers, or a system of sewers and drains, and to provide for the payment of the costs of the construction, operation and maintenance thereof," approved April Third, One Thousand Nine Hundred and Two and Amendments thereto, hereby reports under the hand of its Chairman and Secretary its determination.

The members of the Board, having duly qualified according to law, met on the 13th day of April, 1906, and organized by the election of Rear Admiral Philip H Cooper, as Chairman, and Eugene S Burke as Secretary. Willard W. Cutler, Esquire, was appointed Counsel to the Board.

Morristown has reached a point in its growth where sewerage facilities are absolutely necessary to its general health and prosperity. There are to-day cesspools under buildings in Morristown which have to be pumped out from the cellar through the building to a vehicle in the street.

Furthermore, the streams flowing through the Town are daily polluted by private drains and overflows from cesspools ; the engineers estimate that more than a thousand people are so polluting these streams) so that when they are at a low stage, especially in the summer time, the raw sewage thus turned into them cannot be assimilated by dilution and an intolerable nuisance results therefrom.

The Town is fully warranted in making the necessary expenditures, for aside from the necessity of considering the health of the people it is an indisputable fact the introduction of a system of sewerage will very greatly enhance the value of real estate in the Town and add to its prosperity. This matter being of so much importance to the community it is to be hoped that every tax payer will carefully consider this and the Engineer's report.

After its organization the Board set out to determine the system of sewers most advantageous and for the best interests of the Town.

Finding the maps, plans, estimates and data at its disposal entirely inadequate, the Board, after extensive inquiry respecting the different sanitary engineers who had been under favorable consideration, voted unanimously to employ Messrs Williams, Proctor & Potts, of New York, to prepare and submit a report for the comprehensive sewering of the Town, with a recommendation as to the best method of disposal. The Board of Sewerage, in submitting a report of its work feels that the exhaustive and excellent report of these engineers, herewith submitted, makes it unnecessary to state more than a few facts relating to the subject under consideration, which do not properly belong in the Engineers' report, but which may serve as an introduction to the same

While the necessary surveys and plans were being prepared by these Engineers, the Board inquired into various methods for the disposal of sewage, considering first a connection with the Joint Outlet Sewer at Summit

The Joint Outlet Sewer, completed in July, 1903, was built by eleven (11) separate municipalities in Essex and Union Counties, and runs from Summit to the Arthur Kill, a distance of twenty-three (23) miles. It was intended in the construction of this sewer to provide sufficient capacity for Madison, Morristown and Morris Plains (State Hospital), the extra capacity being taken by Summit with the idea of selling it to these municipalities when ready to connect with the sewer. Summit however, is now unwilling to sell enough space for both Madison and Morristown, and, as the State Hospital has recently renovated its disposal system and will not entertain any proposition for connection with the Joint Outlet Sewer, the entire expense of connecting with the sewer would have to be borne by Morristown alone, if it should now adopt that system.

To connect with the Joint Outlet Sewer at Summit, Morristown would have to construct about fifty thousand (50,000) feet of open cut sewer, and either thirteen thousand (13,000) feet of tunnel under Hobart Hill, or establish a pumping station at this point to pump the sewage over the hill. There are so many objections to the establishment and maintenance of the pumping station that the Board could not consider it except as a last resort. The tunnel is feasible, but, owing to the uncertain character of the soil no engineer will guarantee an estimate without borings, which would cost a much greater sum than the Board has at its disposal

From estimates submitted by competent engineers the Board believes the cost to Morristown of connecting with the

trunk sewer would be at least Four Hundred and Sixty-Three Thousand, Two Hundred and Fifty Dollars ($463,250 00). To this, of course, must be added the estimated cost of sewering the Town Two Hundred and Fifty-One Thousand, Five Hundred and Forty-Five Dollars and Seventy Cents ($251,545 70) making a total cost of Seven Hundred and Fourteen Thousand, Seven Hundred and Ninety-Five Dollars and Seventy Cents ($714,795.70) as the cost of this plan for collecting and disposing of the sewage

While Summit might be willing to share in the expense of building the tunnel the amount so contributed would not exceed the price that Town would demand for the space in the Joint Outlet Sewer required by Morristown—one million (1,000,000) gallons a day which the Board estimates at One Hundred Thousand Dollars ($100,000). The Board has been unable to secure a definite proposition from Summit as to the price to be charge for this space, but bases its estimate of One Hundred Thousand (100,000) on the amount recently demanded of Madison by Summit

In addition to the large estimated cost of this plan for disposing of the sewage there is another serious objection to it. It is not a permanent plan, nor is it a final disposal. The Board believes that the time will come, and probably within the next ten (10) years, when not only the Federal authorities but the people living in the municipalities bordering on the New York Harbor line will demand that the sewage from the Joint Outlet Sewer be purified before it is turned into the Arthur Kill. To comply with such a demand it will be necessary to construct a joint disposal plant and it is estimated that it would cost Morristown nearly as much for its share of such a joint plant as to build a local plant at the present time.

In view of the very large and uncertain investment it would be necessary for the Town to make, and because it believes a perfectly satisfactory system of disposal can be installed through a local plant at a much smaller cost; the Board cannot recommend a connection with the Joint Outlet Sewer.

Since the report of the last Sewerage Commission, in July, 1903, extensive and valuable experience has been gained throughout the country by sanitary engineers, until now the solution of the problem of local sewage disposal, with effective purification is fully and satisfactorily determined and Morristown is in a position to reap the benefit of the most modern and approved methods in the construction of a system of sewerage. Members of the Board have made personal investigation, jointly and individually, of local systems for the disposal of sewage in use in towns in the States of New York, New Jersey and Massachusetts, and they have conferred with the authorities of municipalities in which such systems have been

in use, and the Board is satisfied that a local disposal system of sedimentation tanks, contact beds and intermittent sand filtration will take care of the sewage of Morristown and produce a high and uniform degree of purification.

Only domestic sewage, which lends itself to treatment much more readily than sewage containing large amounts of factory and chemical wastes, is encountered at Morristown, and hence the problem is comparatively simple As a result of very extensive experiments in Massachusetts we know that crude domestic sewage can be finally disposed of in this way and that the putrescible matter in it is destroyed, so that the effluent is not poisonous to fish and is incapable of putrefaction, thus satisfying the requirements of the State Sewerage Commission in cases where the effluent must be discharged into streams forming part of a watershed used to supply other muuicipalities with drinking water.

In considering the best form of disposal plant the Board investigated carefully the disposal of sewage by chemical precipitation. This method of disposing of domestic sewage has been extensively used in England and has proved most unsatisfactory It is very expensive and only prepares sewage for purification, a work economically and effectively done by the sedimentation tank.

Chemical precipitation might be used economically where many large manufacturing establishments contribute chemical and other refractory waste matters which are injurious to the bacterial life of filters. In such a case it would be economical to separate them in a special sewer and make them innocuous by chemical precipitation

This is the situation at Worcester, Massachusetts, where a part of the sewage is so treated. It is not only unnecessary in Morristown. where we have only to deal with domestic sewage, but impracticable.

All the engineers consulted by the Board agree that the low point for the collection of the sewage from within the entire area of the Town is on Ridgedale Avenue, about one hundred (100) feet southerly from the bridge across the Whippany River. From this point it is easy to drain all of the Town lying east of South Street and Madison Avenue and north of Court Street. The territory of the Town, however, is divided by a ridge following generally the line of South Street, so that the sewage from the portion of Morristown lying west of this ridge must be either separately treated or brought into the system lying to the east by pumping or by a special intercepting sewer in the form of a tunnel through the ridge. The Board believes separate treatment to be impracticable and is advised that the tunnel would need to be constructed under air pressure and at great expense, but that the

installation of the ejector type of pumps would be much less expensive and preferable under existing conditions. These ejector pumps are placed in chambers built in the streets so that no real estate or private right of way is required. They are operated by electricity and are nearly automatic. They are not expensive and can be easily and economically maintained. From the low point above mentioned it is practicable to drain the sewage by gravity to a point on the Whippany River where a disposal plant may be built for the purification of the sewage before its discharge in the River. The local disposal works recommended are designed to care for a maximum population of fifteen thousand (15,000), but it is also so designed that it may from time to time be enlarged to care for a much larger population without interference with the general arrangement.

The board has visited different areas suggested for the location of the disposal plant and is unanimous in the choice of the site recommended in the Engineers' report, which is sufficiently large to take care of the increase in population. Within a few feet of this site sand of the best quality—an essential in the construction of the plant—is found in large quantities.

The Board desires to express its entire satisfaction with the work done by Messrs. Williams, Proctor and Potts, and its confidence in the plan recommended by them, and now determines that:

(1) The system of sewers most advantageous and for the best interests of the incorporated Town of Morristown, is a disposal system with sedimentation tanks, contact beds and intermittent sand filtration. The sewage to be carried by gravity (and ejector pumps where necessary) to a point on Ridgedale Avenue in the Town about one hundred feet southerly from the bridge over the Whippany River.

(2) Such system shall extend throughout the whole Town, the sewers to be vitrified tile with water tight joints of different sizes according to the location, varying from eight (8) inches to twenty (20) inches, with man-holes, flushing tanks and necessary appliances, and located substantially as shown on a map filed herewith and made a part hereof.

(3) The sewage to be carried from the aforementioned point on Ridgedale Avenue in a general southerly direction to the old dam, thence crossing the Whippany River and extending in a general northeasterly direction and as nearly as practical parallel with the Whippany River, through a twenty (20) inch cast iron pipe connecting sewer, to disposal works to be located near the road dividing the Township of Morris from the Township of Hanover and near the old burnt mill, said disposal works to be constructed without the limits of the Town of Morristown and in either the Township of Mor-

ris or in the Township of Hanover as shall be considered most desirable as the work progresses.

(4) The manner of disposing of the sewage will be briefly as follows: After the sewage is delivered at the disposal works it will pass through successive stages of treatment, consisting of sedimentation tanks with sludge bed, and contact beds, and the fluid finally, after passing by gravity through sand filters and thus purified, will be conveyed by a vitrified tile pipe to and discharged into the Whippany River.

The total estimated cost of the construction of the system of sewers, disposal works and connecting sewer, as above determined and as is more specifically set forth in the report of the Engineers (and designated thereon as C prime) hereto annexed and made a part of this report is:

Sewer complete in the town	$174,449 95
Disposal works	99,100 00
Automatic pumps for western half	10,100 00
Real estate, right of way, legal and miscellaneous expenses	67,000 00
Engineering superintendence	18,437 25
	$369,087 20

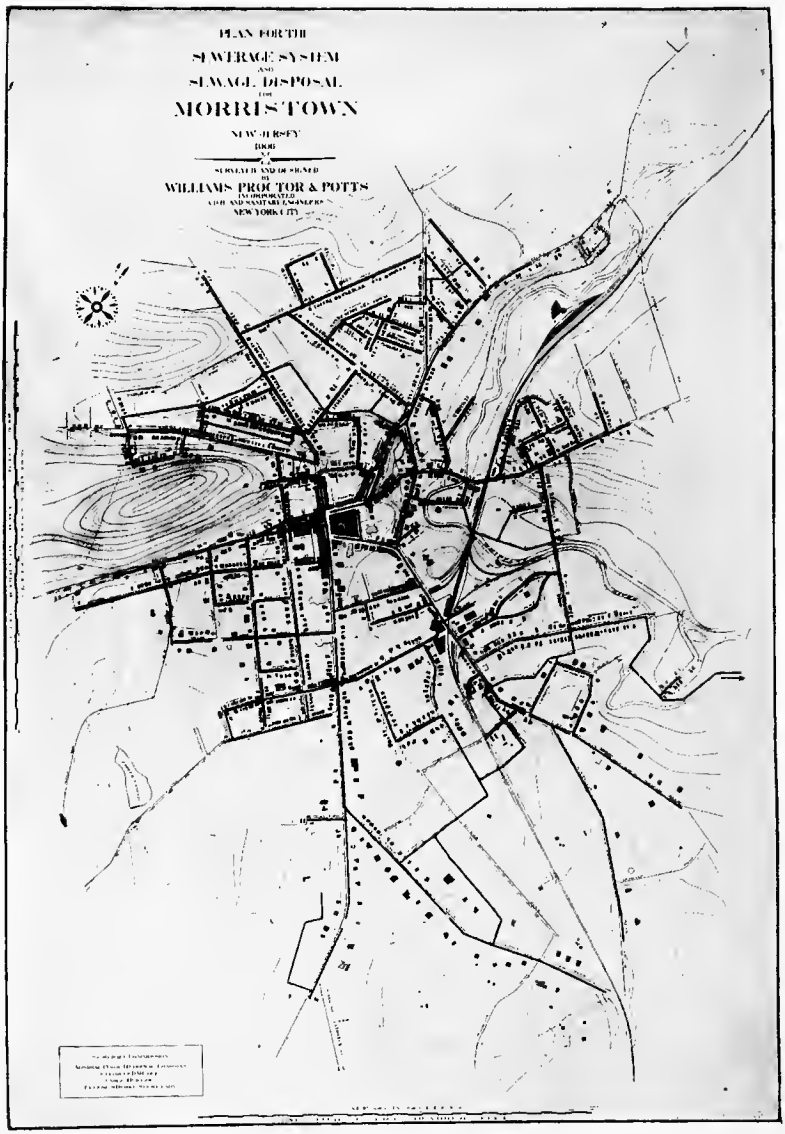
Respectfully submitted,

P. H. COOPER,
Chairman.

Attest:

EUGENE S. BURKE,
Secretary.

Morristown, N. J., February 23rd, 1907.



Showing portions in black lines of the sewers recommended in the Engineers' Report to be built in 1907.

REPORT OF THE ENGINEERS.

December 31st, 1906.

To the Honorable

Rear-Admiral Philip H. Cooper, Chairman; Eugene S. Burke, Secretary; Charles D. M. Cole and Emile Hurtzig, Members of Morristown Sewerage Commission, Morristown, N. J.:

GENTLEMEN:

In pursuance of an agreement entered into with your Honorable Body, dated August 10th, 1906, we submith herewith our Report for the comprehensive sewering of the Town of Morristown, New Jersey, with a proper method of disposal.

GENERAL DISCUSSION.

SEWAGE FLOW PER CAPITA.

§ 1. In designing the sewers and sewage disposal works for Morristown, the information first essential is, of course, the probable amount of sewage for which to provide. Morristown has no public sewers whose flow we can measure, therefore, the nearest approximation to the proper amount can be had only through the per capita cousumption of water as furnished by the proprietors of the Morris Aqueduct, which is 40 gallons per person per day (see letter appended). Assuming the population of Morristown to be cared for in the proposed sewers to be 15,000 persons, would give a sewage flow of 600,000 gallons. Experience shows that when a system of sewers is constructed in a town, people use more water than formerly. For the purpose of our estimate, we have assumed that the per capita consumption of water at Morristown will increase from 40 gallons to 60 gallons per person per day. This gives us a probable sewage flow of 900,000 gallons.

LEAKAGE OR INFILTRATION.

§ 2. No matter what care is taken in the construction of sewers, there is always more or less infiltration of ground water, depending on the character of the soil, the height, etc. This is usually approximated at 10 per cent. of the whole flow, or, in

the case of Morristown, 90,000 gallons per day. This we believe to be ample, for with gaugings of newly constructed sewers built by us in other places, we find that under our specifications the leakage seldom exceeds 3,000 gallons per mile. The profiles of the proposed sewers at Morristown call for 28.0 miles of sewers. With leakage at 3,000 gallons per mile, this would give us 84,000 gallons, which, as will be seen, is about 9.3 per cent. of the sewage flow for which we propose to provide, giving us still a leeway of 16,000 gallons per day on our allowance of 10 per cent. for leakage. Our sewers and disposal plant are accordingly designed to care for a total flow of 1,000,600 gallons of sewage and infiltration.

FUTURE POPULATION.

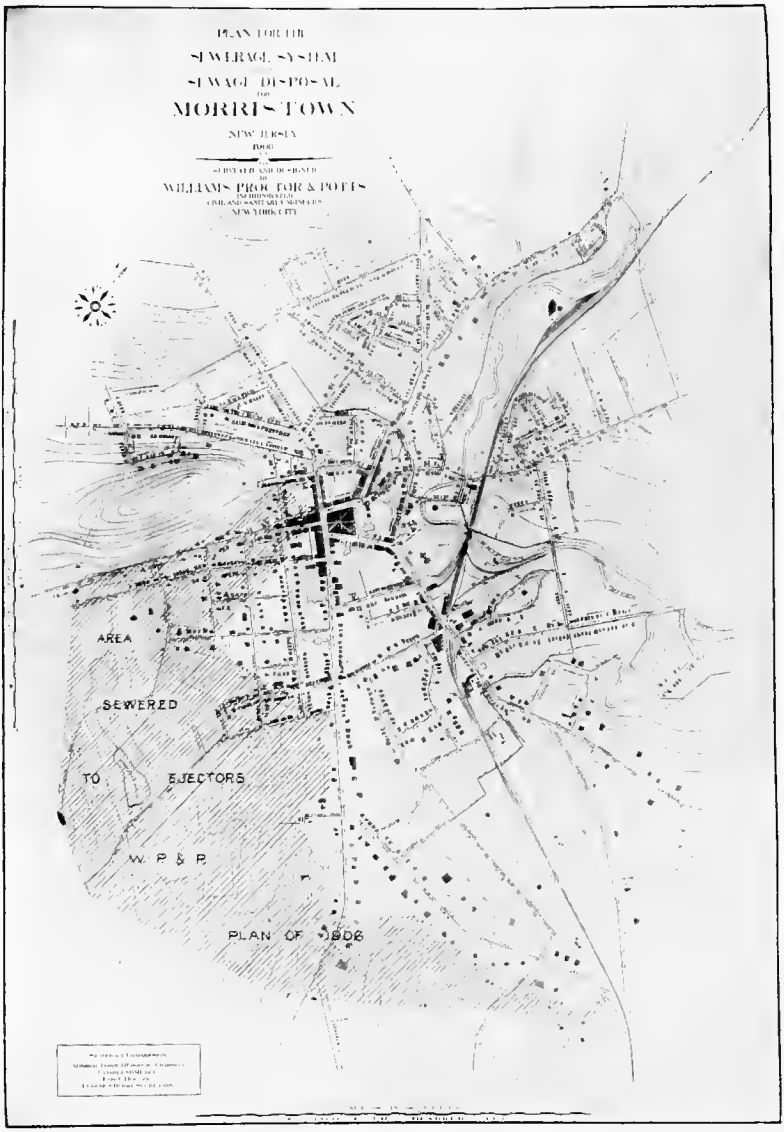
§ 3. It is hardly probable that many more people will live within the Town limits of Morristown,—certainly no considerable percentage of the present population. As a rule, the available building sites within the Town limits are occupied. While Morristown covers approximately 3 square miles, much of this is occupied by large estates, some of them occupying several acres, and it is hardly possible that these will be divided, at least, in this generation. We have, therefore, designed the sewers to care for a maximum population of 15,000, and have designed a sewage plant to treat a corresponding amount of sewage.

ELASTIC DESIGN.

§ 4. The plant is designed to be elastic so that it may be added to without any hindrance to the general arrangments. It is proposed to build 4 sections of the sedimentation tanks at the present time, and any one of these may be thrown out of commission at the option of the operator, or, if desired, the entire sewage can be run through 1 unit and 3 thrown out of commission. The same arrangement is made for each remaining process in the method of disposal.

PRIVATE WAYS.

§ 5. Any system for Morristown must necessarily include an unusual amount of private ways. This is true because of the fact the streets are laid out with no sort of regularity, and also because the physical shape of the Town is such that numbers of creeks and waterways cross private lands; and as a rule it may be said that a system of drainage follows the natural waterways. We have tried in our design to keep the private ways to a minimum, and in all cases have figured the expense of the private way as compared to extra deep cutting necessary to keep the sewers in the streets, and in most cases have chosen the cheaper method, although in some cases we have advocated deep cuts as being preferable to private ways. In the plans as completed, 14 3 per cent. of the sewers are shown crossing pri-



The area unshaded drains by gravity to the Ridgedale avenue outfall. The shaded area is drained to ejectors from which it is forced over the ridge to the main system.

vate lands. These, of course, are mostly trunk sewers and do not serve as laterals.

GENERAL SCHEDULE OF DRAINAGE.

§ 6. The general scheme of the system of drainage shows the low point of the system to be about 800 feet east of Abbett Avenue on Ridgedale Avenue. From this point it is very easy to drain all that portion of the Town lying east of South Street and Madison Avenue and north of Court Street, shown on Plate II as unshaded.

EJECTORS.

§ 7. In draining the remainder of the Town, as shown on Plate II shaded in light lines, three ways present themselves—

First—By running a tunnel under the ridge at Madison Avenue South Street, as recommended by Messrs. Herring & Fuller in their scheme of 1902. However, some equally advantageous location might be chosen.

Second—By installing a pumping station or ejector chamber at Green and James Streets, and one on Wetmore Avenue to pump all the sewage over the ridge to a manhole at James and South Streets, and to a flush tank at Maple Avenue and DeHart Street respectively. The sewage so pumped amounts to approximately 120,000 gallons per day. Other small ejectors could be built when needed, one being at the point where South Street crosses the Town line. These ejectors, which it is proposed to operate by electricity, will be automatic, the electrical device beng set in operation and stopped by means of a float in the ejector chamber which rises and falls with the sewage.

Third—By treating the sewage of the western portion of the Town in an independent disposal plant.

SEWER GRADES.

§ 8. In laying out the sewers we have adopted for the minimum grades the following:

8	inch	0.5
10	"	.35
12	"	.26
15	"	.16
18	"	.11
20	"	.09
24	"	.085

These grades will give a minimum velocity of 2 to 3 feet per second in the pipes, which experience has shown to be a self-cleansing velocity. The trunk sewers are about the only pipes that are affected by these minimum grades, the greater percentage of the laterals being laid on steeper grades to conform to the shape of the ground. Most of the sewers are laid at a minimum depth

of 9 feet, in some cases more, as the depth of cellars were noted at the time of making the surveys and in nearly all cases it is attempted to lay the sewers at a sufficient depth to drain cellars.

FLUSHING.

§ 9. Automatic flush tanks can be placed at the dead ends of laterals, laid on a less grade than 1 per cent. In every case where the dead ends are laid on grades exceeding 1 per cent, flushing manholes are sufficient. This type of a flushing manhole allows inspection of the dead ends and also flushing at periodic intervals. In flushing, the manhole is filled with water, the end of the pipe having been previously covered by a flap. Upon the removal of the flap, the contents of the manhole are allowed to rush through the sewer. This method of flushing gives a flush wave the full bore of the sewer, and its effects may be traced a thousand feet down the sewer.

PERIODIC VS. AUTOMATIC FLUSHING.

§ 10. The question of flushing is one that is by no means solved, the evidence for and against being about evenly divided between periodic flushing of this kind and automatic flushing. Indeed, there are advocates of the idea of no flushing at all. Mr. F. S. Odell, of Portchester, N. Y., in an exhaustive article in the Transactions of the American Society of Civil Engineers in 1893, describes the sanitary sewers of Portchester in which periodic flushing only is used. His experiences indicate that automatic flushing is a double waste of money, there being the first cost of the flush tanks and the cost of the enormous amount of water used by them annually.

COMPARATIVE COST OF PERIODIC VS. AUTOMATIC FLUSHING.

§ 11. In Morristown there are approximately 126 dead ends which would require 126 flush tanks at a cost of $50.00 each more than flushing manholes. This item of first cost would amount to $6,300.00. The tanks would consume daily 33,900 gallons of water, which equals 13,797,000 gallons per year, which at 15c per thousand gallons, amounts to $2,069.75 per year for water alone. The interest on the first cost at 5 pc. would amount to $315.50 per year, making a total annual cost of $2,384.75 as the charge against automatic flushing. On the other hand, with periodic flushing, it would require, as experience has shown in 6 towns in New England, flushing 4 times a year, which, for the 126 flush tanks, would require perhaps 157,000 gallons, which, insofar as cost or value is concerned, is insignificant, but it would require the services of one attendant for at least 22 days during the year. This with the water, at most would amount to scarcely more than $100.00 per year, and as before shown, is offset by a charge of $2,384.76 for automatic flushing. In view of this, and also the lack of conclusive data by the advocates of automatic flushing, we recommend periodic flushing

for Morristown. Periodic flushing is very effective when properly done, for it is begun at the flush tanks lying at the higher elevations, and from these tanks the sewers are flushed downward to the lower elevations, and any refuse lying in the upper reaches of the sewers is thus completely washed out. In using automatic flush tanks on a system where the sewage is treated in a disposal plant as at Morristown, the fact must not be lost sight of that capacity must be provided in the disposal plant for 37,800 gallons of water contributed by flush tanks. While this is an inconsiderable amount, it represents, however, a proper charge against automatic flush tanks.

INVERTED SIPHONS.

§ 12. In four cases we have designed inverted siphons to carry the sewage across creeks and waterways. These are in accord with the best practice in sewer design, and make it possible to carry the trunk sewers under creeks. They are located on Atno, Ridgedale and Abbett avenues and Water and Centre streets.

SIZE OF SEWERS

§ 13. The minimum size of sewers is taken at 8 inch, which is in conformance with the best practice. Some Engineers, notably the English Engineers, recommend 9 inch as the smallest allowable. While a less size than 8 inch might be large enough to carry the quantity it would receive, the danger of stoppage is very much greater. All sewers are designed to flow half full.

CHARACTER OF MORRISTOWN SEWAGE.

§ 14. The sewage of Morristown is composed of practically domestic sewage only. Sewage of this quality lends itself to treatment much more readily than a sewage containing large amounts of factory or creamery wastes. We anticipate no difficulty in the treatment of Morristown sewage by any method of treatment now accepted as good practice among Engineers. Many of the complications that arise in the treatment of sewage in other localities are due to large amounts of dye, creamery, packing house or other industrial wastes. These add not only large quantities of solid matter to the sewage, but are generally supposed to contain chemicals and other ingredients detrimental to bacterial action in the process of treatment. For Ravenna, Ohio, where a plant of about the same size as that proposed at Morristown is now in course of construction, we recommended a method of disposal consisting of sedimentation or septic tanks followed by intermittent sand filters. The sewage contains about 27 per cent. of factory wastes of which nearly 23 per cent. were wastes from a dye house containing large quantities of chemicals, including sulphuric and other acids. This dye house contributed 225,000 gallons of sewage per day. Our recommendations for intermittent sand filtration following sedimentation, were

accepted and approved by the Ohio State Board of Health as one of the best known for treatment of sewage of this character.

At Morristown, as before stated, we have only domestic sewage to treat, and the problem is comparatively simple.

WHIPPANY RIVER.

§ 15. The Whippany River into which the effluent must discharge, regardless of the method of local disposal, drains into the Passaic River above Little Falls, consequently, the effluent of a disposal plant should be purified "to the highest practical degree," and should also be of as uniform a quality as possible. Inasmuch as the waters of the Whippany River are used for drinking purposes at a point lower down by other municipalities, Morristown would not be justified in turning an effluent into these waters that is not uniformly purified to a high degree. Beyond a question, at least 1,000 persons in Morristown now turn their raw sewage into the Whippany River; at a low stage of the river this cannot be assimilated by dilution, which is visibly apparent. A disposal plant in our judgment will materially improve the present quality of the water of the Whippany River. There is an old theory that running water will purify itself. Morristown can get no consolation from this, because the State Sewerage Commission has a dictum that "no river in New Jersey is long enough to purify itself."

ATTITUDE OF THE STATE SEWERAGE COMMISSION.

§ 16. Morristown has no moral right to discharge crude sewage or any improper effluent from a sewage disposal plant into the Whippany River. Neither has it a legal right to do so and should such an attempt be made, the municipalities affected have recourse to order the cessation. Again the attitude of the State Sewerage Commission is such that only a plant giving the highest practicable degree of purification will meet with their approval. In our designs and recommendations we have attempted to secure proper disposal at as low a cost as possible, and have endeavored to carry out the teachings and high ideals which should govern a sanitarian in the design of works which so affect the health, happiness and lives of a population. We trust and believe that the Sewerage Commission and the Mayor and Board of Aldermen of Morristown will adopt our recommendation, together with such means as to conserve the health of the people of Morristown, as well as other municipalities affected.

INVESTIGATIONS.

OUTLINE.

In selecting the most suitable and economical method of collection and disposal of Morristown sewage, the results have been achieved by a process of elimination. That is—in dealing

with any particular problem, we have endeavored to consider all possible solutions with regard to their cost, efficiency, maintenance and durability, and then to eliminate those that are prohibitive or impractical in any of the features above mentioned.

1st. Study. In the collection of the sewage from the Town, we are at once confronted with the impossibility of draining the sewage to one common point without recourse to

Plan—(a) long stretches of deep cut and tunneling, involving many private ways owing to the topography elsewhere described:—

Plan—(b) pumping the sewage of the westerly portion of the Town over the ridge, or—

Plan—(c) installing two disposal plants.

2nd Study. After having collected the sewage to a point of primary disposal near the bridge across the Whippany River on Ridgedale Avenue, we are again confronted with different methods of drainage to final disposal, namely:

Plan—(a) to discharge the raw sewage into the Whippany River.

Plan—(b) to discharge the crude sewage intothe Arthur Kill by constructing about 50,000 feet of open cut sewer to the western slope of Summit—13,500 feet of tunnel under the mountain at Summit; 17,000 feet of open cut sewer to the joint outlet sewer proper and 50,000 feet to the Arthur Kill from this point.

Plan—(c) to drain the sewage to a point far down the River, utilizing the mill race bank, where sufficient fall may be had to build a disposal plant operated by gravity, and

Plan—(d) to pump the sewage from the point of primary collection to a disposal plant located near the point of primary collection within the limits of Morristown.

3rd Study. A proper method of disposal by either

(a) artificial beds
(b) natural beds
(c) chemical precipitation.

MINUTIÆ OF FIRST STUDY.

HERRING & FULLER PLAN.

Plan—(a) Messrs. Herring & Fuller, in 1902, submitted to the Town Authorities a plan for the collection of sewage which contemplated the collection by gravity and involved long stretches of deep cut, together with about 1,500 feet of tunnel. This plan, as recommended by them for collection by gravity alone, is about the only comprehensive plan that will sewer the major portion of the Town. It is, however, subject to the following criticisms aside from financial considerations. These

criticisms might or might not condemn the plan, according to the personal equation of the critic.

FIRST OBJECTION.

The plan does not sewer the entire area of Morristown, but leaves the area below contour 315 unsewered except by pumping.

The amount so unsewered is shown on Plate III. To sewer the entire Town by gravity would require the trunk sewer proposed by Messrs. Herring & Fuller, including the tunnel to be lowered 20 to 25 feet, which would, of course, reduce the whole plan to impracticability. It will be stated that the plan as contemplated practically sewered the entire town, and while this is true, nevertheless, it does leave an area unsewered that may be built up more or less within a relatively short time. A sewer system will last for generations and its layout should contemplate caring for the sewage of future generations.

SECOND OBJECTION.

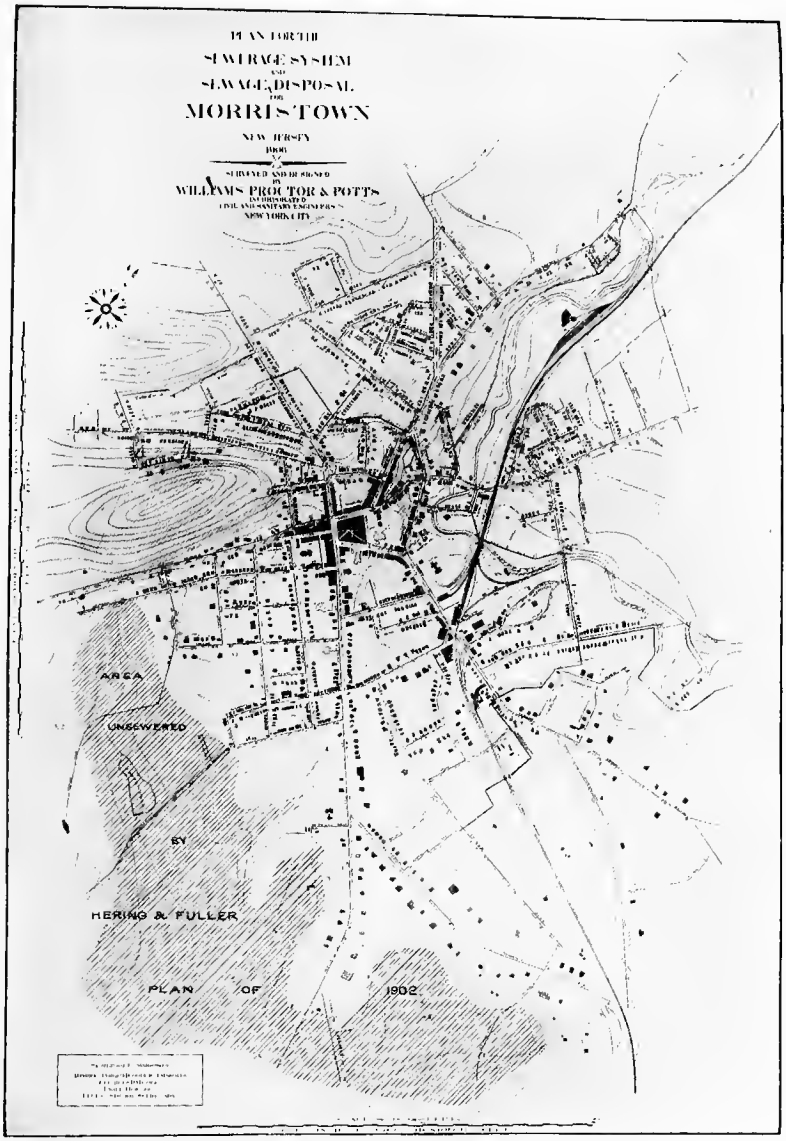
The major portion of the trunk line as proposed, is laid in marshy ground, and would be subject to the infiltration of large quantities of ground water. This would bring a large volume of infiltrate to the disposal plant which would add to the expense of disposal. Probably a large portion of this trunk line would need to be built of cast iron pipe which again would add to the expense. These items are not considered in the estimates. Between DeKalb Avenue and the D., L. & W. Railroad across the Ball Ground, the line is 20 feet deep, and it is more than probable that very difficult trenching would be encountered here. Between DeKalb and Madison Avenues, the sewer is from 20 to 30 feet deep with similar ground.

THIRD OBJECTION.

The sewer crosses private lands almost entirely, and these rights of way could probably be secured only at large expense and delay; especially is this true if condemnation proceedings were resorted to.

FOURTH OBJECTION

The tunnel, as constructed under the hill south of Madison Avenue, is built largely in sand and in which the ground water stands to a considerable height, presumably over the proposed tunnel at all times This means that the tunnel would need to be built under air pressure and at great expense. No responsible Contractor would care to bid on the tunnel unless borings were made at his or the Town's expense; with the borings, should they be unfavorable, his bid would be higher, and without them it is only a matter of guess work as to the cost. Such a tunnel for sewer purposes, and with so much argument against it, is a hazardous proposition at best. We have prepared the fol-



Showing portion of the town unsewered by the scheme of 1902 and which can be served only by pumping.

lowing made up from costs for similar work under similar conditions, and believe this to be the minimum cost for the project. Should this plan be adopted, we would recommend that the Town make the borings before asking for bids.

ESTIMATE OF SEWERING BY GRAVITY.

5,125 feet 18 inch pipe at $2.50	$12,812 50
1,500 feet Tunnel at $20.00	30,000 00
3,350 feet Open Cut at 3.00 (20'–30') deep	10,050 00
Cost of Sewering by Gravity	$52,862 50
Interest and Sinking Fund at 4 1-2 per cent	2,114 50
Annual Per Capita Cost	0.141

Plan—(b) In disposing of the sewage from the western slope by pumping, we have considered the ejector type of pump, as this is nearly automatic and is equally applicable whether the Town builds a pumping station on Ridgedale Avenue to pump the sewage to a disposal plant, or whether the sewage is ultimately disposed of by gravity. In case the pumping station is not built, the ejectors can be operated by electricity from the local lighting company. Should the pumping station be built, as explained in paragraph (d) Second study, a dynamo can be installed which will generate electricity to operate the ejectors and at the same time generate electricity to light the pumping station and grounds.

OPERATION OF EJECTORS.

These ejectors are placed in chambers built in the streets and in operation they act as follows: As the sewage enters the ejector chamber, it is stored up until such a pre-determined quantity has collected to set the ejector in operation, when, by a type of air pump, the sewage in the chamber is elevated to any chosen point through a cast iron pipe. Ejectors of this type are used extensively for this purpose, in fact, nearly all the big buildings in New York where the sewage drains to a point below tide, the sewage is discharged in this manner. The sewage of the World' Fair at Chicago, which was collected below lake level, was discharged in this manner.

ADVANTAGE OF EJECTORS.

One great advantage of the ejectors over the tunnel and which does not appear in our estimate, is that the ejector system does not require a foot of ground or private right of way. These estimates, as all estimates in this report, are exclusive of real estate and right of way.

COST.

We estimate the cost of three such ejectors, one located on

Mt. Kemble Avenue near the Hospital, one on Green street at the corner of James and one on South street at the Town Line, as follows :

FIRST COST—ESTIMATE OF SEWERING BY EJECTORS.

3 Ejectors, Dynamos, Machinery complete,	$3,300 00
5,300 feet 6 inch Discharge Pipe,	5,300 00
3 Ejector Chambers,	1,500 00
	$10,100

Wiring is not included as it is presumed that the Town has franchise rights in existing conduits or pole lines. In case the electricity is bought from the local company, they will furnish their own delivery.

OPERATION—MAINTENANCE.

NOTE—The lesser permanence of some classes of work requires a greater per cent. for sinking fund charges.

Interest and Sinking Fund on $10,100 at 5 per cent,	$505 00
Operation and Electricity,	438 00
Cost of Maintenance,	$943 00
Per Capita Cost,	0.063

REMARKS.

This method of caring for the sewage possesses the advantage before noted over that outlined in Paragraph (a) First Study, in that the ejectors can be located so as to care for the sewage of the entire district. No private lands need be acquired, a feature which does not appear in the above discussion as the estimates given, as before stated, are exclusive of real estate. The ejector system will shorten the time of execution of the contract materially, as the ejectors can be built much more quickly than the tunnel.

The ejectors are as nearly automatic as it is possible to make them, and further than occasional inspection will need little attendance. In case of accident or breakdown, no damage is liable to occur as the ejector chambers are provided with an overflow, also an alarm to indicate to the attendant at his office that attention is needed.

EJECTORS ARE MOVABLE.

The ejector at Green and James Streets is located at this point temporarily. When necessity requires, it can be located at the bridge on James Street below Foote's Pond. In this location it will collect the sewage from any houses that may be built on James Street below Green Street.

SEWERING WITH TWO DISPOSAL PLANTS.

PLAN (c) The matter of providing a separate disposal for

the western district has been rejected from consideration principally for the reason that no site is available that will give sufficient fall to operate a separate plant and at the same time drain the entire area. It could be accomplished by pumping, but were pumping resorted to, the sewage could be pumped to the other plant with almost equal facility. Further, the cost of a plant to care for 120,000 gallons per day would more than equal the cost of the ejectors as estimated above.

MINUTIÆ OF SECOND STUDY.

DISPOSAL BY DILUTION.

PLAN (a) To discharge the crude sewage into the Whippany River would not be tolerated by the State Sewerage Commission, inasmuch as the Whippany River is located in the water shed of the East Jersey Water Company, which supplies Jersey City and some of the West Hudson towns. The flow of the Whippany River is so small at times that it is doubtful if a serious nuisance would not be caused even were the lives of the people supplied by the East Jersey Water Company not jeopardized by the pollution. The present condition of the river at times borders on being a nuisance and only a small per cent. of the people sewer into it clandestinely or otherwise. Should any considerable portion of the population sewer into the river, it would lose its power of assimilation and a nuisance would ensue. This method is not to be considered.

DISPOSAL IN ARTHUR KILL.

PLAN (b) To discharge the sewage into Arthur Kill would require the construction of—

1st—Some 50,000 feet of new sewers.

2nd—Securing the consent of Summit and Milburn to use a portion of 17,200 feet of trunk sewer owned by them and

3rd—Securing a space in 50,000 feet of the joint trunk sewer built by the eleven municipalities in Union and Essex Counties owned by Summit.

The cost of this method for the pipe line, exclusive of real estate and based on available data, approximately is as follows:

ESTIMATE OF DISPOSAL TO ARTHUR KILL.

45,000 feet, 24 inch Pipe to Summit at $2.50	$112,500 00
13,500 " 48 inch Tunnel at $20.00	270,000 00
To Rights in Joint Sewers	100,000 00
	$482,500 00
Incidentals at 10 per cent.	48,250 00
Total,	$530,750 00

Interest and Sinking Fund at 4½ per cent.	23,883 75
Per Capita Cost	1.592

And, the expense of maintenance, though inappreciable, should be considered.

JOINT SEWER WITH MADISON, CHATHAM AND WEST SUMMIT.

Should Madison, Chatham and West Summit be interested in the project and share a burden of the expense, the figures would need to be materially revised, although it is doubtful if the cost per capita in that event could be reduced below 0.85 or 1.00. This being outside the province of your engineers, we have not devised any apportionment of cost between the municipalities named. It might be said that the charge of $270,000.00 for tunnel could, as an alternate plan, be invested in a pumping station to pump the sewage over the mountain at Summit. Such a pumping station would be similar in design and cost to that described in paragraph (d) Second Study.

OBJECTIONS.

Aside from the tremendous estimated cost of the project of disposing of the sewage by a trunk sewer to Arthur Kill, there are two very good objections—

1st. No one can foretell the conditions to be met with in prosecuting work on the tunnel. In case quicksand or running gravel is encountered, the cost would be extremely high, perhaps higher than our estimate by a large sum. Before receiving bids the Town would need to make borings and investigations as to the character of the soil so that contractors could bid intelligently. The result of these borings might throw out the whole project as impracticable or impossible at any reasonable figure. Mr. Wm. M. Brown, Chief Engineer of the Metropolitan Sewerage District of Boston, estimated a similar project at $25 to $30 per lineal foot, so that in all probability our estimate is the minimum figure for which the tunnel could be built if the very best possible conditions were encountered for tunnel construction. A project of the magnitude of this trunk sewer is an entirely unjustifiable solution for disposing of Morristown sewage for a second and greater reason than the uncertainty of the final cost, which is as follows:

2nd. The sewage is not disposed of by the trunk sewer except temporarily. No man can say that the subscribers to the joint trunk sewer can perpetually empty their sewage into the Arthur Kill. If the outlet sewer emptied into deep water or far out into the ocean, or even into the New York Bay, it might be said with some assurance that it would be tolerated by the authorities for ten, twenty or thirty years. Emptying,

however, as it does, into Arthur Kill, the tendencies of the times and the rapid advance in sanitary science, lead us, as your Engineers, to condemn the project of sewering into Arthur Kill. We do not consider it practical owing to the high first cost nor do we consider it permanent because emptying sewage into Arthur Kill, as a subscriber to the joint outlet sewer, is not final disposal. We believe the time will come in this generation perhaps, when it will be necessary for the sewage from the joint outlet to be purified before turning it into the Arthur Kill. When this is done it will cost Morristown nearly as much for its share of the joint disposal plant as to build a local disposal plant at the present time. Should this transpire, the tremendous cost of the trunk sewer project would be an asset of no value and one on which the maintenance would increase with its age.

To show the probability of Federal interference with the joint outlet sewer, we quote the following report of a Board of Engineers appointed by the Government to pass on the project of emptying the Passaic Valley trunk sewer into Newark Bay. This report is adverse and destroyed the possibility of Paterson and Newark obtaining an outlet for this sewer in Newark Bay. This report clearly reflects the attitude of the Federal authorities on the subject of emptying sewage into navigable bodies of water where shoaling is liable to occur.

HARBOR LINE BOARD.
New York City, May 28, 1897.

Brig. Gen. John M. Wilson, Chief of Engineers, U. S. A., Washington, D. C.

GENERAL:

In compliance with instructions contained in 6th endorsement, dated April 12th, 1897, upon a letter from the Passaic Valley Sewerage Commission to the Secretary of War, dated March 24th, 1897, having reference to the question of the possible interference of navigation of the plans for sewage disposal proposed by the Commission, the New York Harbor Line Board has the honor to submit the following report:

The plans proposed by the Commission, which are described in detail in the printed report accompanying its letters above referred to, contemplate the discharge of all the sewage collected in what is called the lower Passaic district upon the flats of Newark Bay at a point about 2,200 feet above the bridge of the Central Railroad of New Jersey. The Board is required by your instructions to examine and report upon the question of the probable effect of the scheme upon the navigable capacity of Newark bay and adjacent waters.

The navigable channels which would be affected by the proposed scheme of sewage disposal are the channel of the Passaic River between Passaic and the Centre street bridge in Newark; the channel extending from Centre street bridge in Newark to deep water in Newark bay; and the channel on the South side of the bay connecting the Arthur Kill with the Kill von Kull. The conditions in these channels are briefly as follows:

Channel Above Newark. This channel extends from Centre street bridge, Newark, to the City of Passaic. The United States has expended $140,000 upon its improvement since 1872, and the work is still in progress. The project provides for a channel from 200 to 50 feet wide and from 7½ to 6 feet deep at mean low tide.

Channel Below Newark. This channel extends from deep water in Newark Bay to Centre street bridge, Newark. Between 1880 and 1886, the United States expended $170,000 in improving it to a width of 200 feet and a depth of 10 feet at mean low water, and the annual cost of maintenance has been $16,000.

Channel Between the Arthur Kill and the Kill Von Kull. This forms a part of the channel separating Staten Island from the State of New Jersey, which is 17 miles long, extending from Perth Amboy, N. J., and Tottenville, S. I., to Constable Point, N. J. and New Brighton, S. I. The waterway is generally narrow, having a least width of about 500 feet. Its original depth was at least 15 feet at low water, except for a length of about 1¾ miles opposite the mouth of Newark Bay, where the depth was 9½ feet in a narrow channel bordered by flats. The channel has been improved by the United States by deepening the passage across this shoal; and further improvements are contemplated. The project provides for the formation and maintenance of a channel between the Arthur Kill and the Kill von Kull, 400 feet wide and 14 feet deep at mean low water, at an estimated cost of $210,000. The annual cost of maintenance is estimated by the District Engineer at $10,000.

The channel connecting the Arthur Kill and the Kill von Kull is commercially of much greater importance than those extending through the Bay, up the Passaic River, the traffic of the former in 1895 having been estimated at 9,865,000 tons while that of the latter was only 1,259,000 tons

According to the report of the Sewerage Commission, the quantity of sewage now daily discharged into the Passaic River, is about 75,500,000 gals., of which about 49,500,000 gallons enter the River below the Dundee dam, and about 26,000,000 gallons above it. The sewage entering the River below the dam

must increase the rate of shoaling in the channel and thereby increase the cost of channel maintenance. The material entering the River above the dam is doubtless deposited in the upper part of the River and in Dundee Lake, and can have little or no effect upon the navigable channel which terminates below the dam. The plan of the Commission proposed to discharge all this material into Newark Bay whence it may be moved by the currents into navigable channels, thereby increasing about 50 per cent. the quantity available to produce shoaling.

Should the outlets for sewage discharge be removed from the river to the bay, as proposed by the Sewerage Commission, the effect in the channel of the Passaic River would probably diminish the rate of shoaling; but the Board is of the opinion that, owing to the location of the new outlet and the increased quantity of the material to be discharged, the rate of shoaling would be increased in the channel between the mouth of the river and deep water in Newark Bay, especially at the lower part.

The most important question, however, in connection with the proposed plan of sewage disposal is its probable effect upon the channel connecting the Arthur Kill and the Kill von Kull. As has been before remarked, the commercial importance of this channel is vastly greater than that of the others. It will, under any circumstances, require more or less dredging for its maintenance. The Board is of the opinion that the concentration and discharge of all the sewage of the lower Passaic district at a point only 1¼ miles from this channel cannot fail eventually to seriously increase the rate of shoaling therein. Such an increase will not only augment the cost of dredging, but will also prolong the time during which the channel must be obstructed by machine.

From natural causes incident to the partial antagonism of the flood currents flowing into the southern end of Newark Bay from opposite directions, the navigable channel leading to Elizabethport has always been subject to shoaling, requiring annual expenditures, of greater or less amount, for maintenance. These effects are clearly apparent in the wide shoals in the vicinity of Shooter's Island and the Corner Stake Light.

The estimated annual deposits of 650,000 cubic yards of solid material in the lower end of Newark Bay following the adoption of the proposed sewer system, would fill up the entire area of the Bay below the proposed sewer outlet, from bank to bank, to the depth of about one third of a foot annually, if evenly distributed.

As the existing average depth of the flats, except in the

narrower width of the improved channel, is about four feet at mean low water, it is easy to see that it will require only a few years to make the proposed sewer system not only a public nuisance but a serious obstruction to the navigable waters adjacent to the harbor of New York.

The Board is of the opinion that, as a general rule, when it is desirable to discharge sewage or other materials into tide water, it should be done at points where natural deep water exists, and not in the vicinity of artificial channels which require periodical dredging for their maintenance. Newark Bay is a land-locked tidal basin of considerable area with comparatively small outlets, through which it will always be difficult to maintain channels of a depth adequate for navigation. The Board is of the opinion that it is not advisable to permit the use of such a basin as the receptacle for a large and constantly increasing amount of sewage. Even if the dilution of the sewage, for which provision is now contemplated, should be sufficient to prevent serious deposits it is certain that the amount to be discharged will rapidly increase and eventually produce shoaling in the channels.

The Commission recognizes the fact that this sewage cannot be indefinitely emptied into the waters of the Bay, and then a time will come when other means must be adopted for its disposal.

The Board concurs in the opinion of the District Engineer that the disposal of the sewage of the lower Passaic district in the waters of Newark Bay will be detrimental to the interests of navigation.

Respectfully submitted.

HENRY M. ROBERT,
Colonel, Corps of Engineers.
G. L. GILLESPIE,
Colonel, Corps of Engineer.
C. W. RAYMOND,
Major, Corps of Engineers.
H. M. ADAMS,
Major, Corps of Engineers.

July 12, 1906.

DISPOSAL BY GRAVITY.

PLAN (c) To drain the sewage by gravity to a point on the Whippany River where a disposal plant may be built.

Surveys were made to locate a suitable site for such disposal works, and two pieces of ground about 4,000 to 5,000 feet down the river from the Ridgedale Avenue bridge were chosen. They are situated near the road leading to Monroe where it crosses the river. These sites are about 1,000 or 1,500 feet

easterly from the sand pits on the Erie Railroad, where an admirable quality of sand can be obtained. These sites could be reached by about 4,000 feet of 20 inch pipe (most of which would be cast iron) laid along the old mill race. This outfall pipe would discharge into the disposal works at about an elevation of 280.8 and the outfall from the disposal works could discharge at an elevation of 267, giving a gross working head through the plant of 13.8 feet. This would, of necessity, limit the type of disposal works to intermittent sand filtration preceeded by sedimentation tanks, and possibly, contact beds. For intermittent filtration and sedimentation tanks, fully six acres of sand filters would be required, allowing for an application of 150,000 gallons per acre (approximately 5½ inches) per day. To build six acres of filters on the site chosen would require considerable cleaning and grading and the lower side of the beds protected by a rubble wall along the river, approximately 1,000 lineal feet.

The cost of disposal without pumping is as follows:

ESTIMATE OF DISPOSAL WITHOUT RESORTING TO PUMPING.

4,000 feet 20 inch pipe at $5 00,	$20,000 00
6 Acres Filters, including grading and grubbing,	48,000 00
Sedimentation Tanks, Buildings and Machinery,	9,000 00
Sludge Bed, Piping, etc.,	8,000 00
1,000 feet Rubble Wall,	5,000 00
Cost of Disposal Works,	$90,000 00
Maintenance estimated at approximately,	2,000 00
Interest Charges and Sinking Fund at 5 per cent,	4,500 00
Annual Cost,	$6,500 00
Annual Per Capita Cost,	0.433

These figures are all based on cost of construction exclusive of real estate. It would, of course, be necessary to secure rights along the mill race or buy the property outright, and also to secure about ten acres or more of ground for the disposal works.

PRELIMINARY TREATMENT.

PLAN (e') Any system of disposal for Morristown designed to give the "highest practicable degree of purity" must be some method of sand filtration. The design might contemplate the discharge of raw sewage on to either natural or artificial sand beds. According to different ideas of different engineers, the raw sewage might have a preliminary treatment with septic or sedimentation tanks; trickling or primary filters; contact beds; double contact beds, aeration—forced or

natural. One of these, or a combination of them, might precede filtration. One of these, or a combination of them, might, and experience shows they do, give a nonputrescible effluent. None, however, in the light of present American practice, give the highest degree of purification practicable. A preliminary treatment by one or more of the above mentioned methods, will serve, however, to reduce the solids in the sewage and otherwise better adapt it to sand filtration, thereby reducing the size of the sand filters and prolonging their useful life. It is a mistake, at least in view of present day knowledge, to believe that sewage can be treated successfully without a solid residue in some form. There are certain chemical compounds, stable perhaps, if the plant is giving satisfaction, which must appear in a solid form, and these must be cared for. Mr. R. W. Pratt states that at Mansfield, Ohio, the amount of sludge removed from the septic tanks after four years' operation was 0.8 cubic yards for each million of gallons of sewage treated. At this place they have contact beds which are undoubtedly becoming clogged. If to the information above given, Mr. Pratt had stated the approximate amount of sludge retained by these beds, the data would be somewhat comparable to what might be expected at Morristown. It must be borne in mind that any device preceding sand filtration will prolong the life of the filters and reduce their size, but it must also be remembered that any relief afforded the sand beds does not relieve the disposal plant. The work of the filters in removing the solids is transferred to the preliminary devices.

PROPER MAINTENANCE.

The addition of preliminary devices tends to complicate the plant and more skilled attendants are required in its operation. For a plant the size of the one proposed for Morristown, a complicated plant is hardly justified. Any disposal plant requires proper maintenance. By proper maintenance is meant that one man should be in attendance at the works and

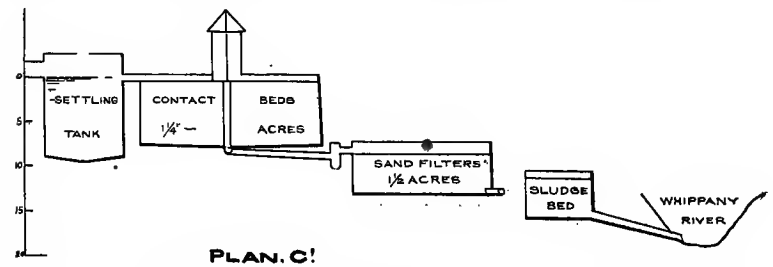


FIG. I. Ideal section showing profile through disposal plant, Plan C', with relative elevations.

be responsible for its operation. He should have such assistance from time to time as the needs of the work demand.

CONTACT BEDS USED.

While we have only a gross working head of 13.8 feet through this plant, we have considered giving the sewage preliminary treatment in septic or sedimentation tanks and contact beds. A profile through the plant shows the following elevations:

Inlet to Sedimental Tank	280.3	feet
Surface of Contact Beds	280.4	"
Outlet " "	272.5	"
Surface of Sand Filters	272.3	"
Outlet of Sand Filters	267.8	feet
Surface of Sludge Bed	269.7	"
Outlet " "	265.2	"
River Surface normal	263.0	"
Bridge across River (floor)	268.9	"

For purpose of a better understanding, the bridge across the Whippany River has an elevation of 268.9 feet which means that the bottoms of the filters are scarcely a foot below the floor of the bridge, and the bottom of the sludge bed is 3½ feet below this floor. With an arrangement of this kind, water would enter the underdrains of the filters only when the river was so high as to be but one foot below the floor of the bridge. To enter the sludge bed, it would need to rise to within 3½ feet of the bridge, which it would probably do. To overcome this objection, sludge from the septic tank would need to be drawn off in times of drouth when the stage of the river is low. It is not certain by any means that water in the underdrains of the sludge bed would be detrimental to the plant to the extent of impairing its efficiency. It certainly would not be objectionable to the physical working of the plant. Again, the sludge bed is to be used for sludge removal at comparatively rare intervals, and to be used for an additional filter at the option of the attendant. We would say that to endanger the plant as designed, the water in the river would need to rise to a point within a foot of the bridge floor. Our estimate covers the expense of building a rubble masonry wall along the river to protect the plant. We have estimated contact beds six feet deep to receive sewage at the rate of about 1,000,000 gallons per acre per day. With this preliminary treatment, we believe the sand filters can operate successfully at 660,000 gallons per acre per day, reducing their size to 1½ acres.

COST WITH CONTACT BEDS.

Estimate of Intermittent Filtration Preceded by Sedimentation Tanks and Contact Beds.

Sedimentation Tank and Machinery	$10,500 00
Contact Beds and Building	49,000 00

Piping, Valves and Manholes	2,100 00
Sand Filters	9,000 00
Sludge Bed and Piping	3,500 00
4,000 feet Rubble Masonry Wall	5,000 00
4000 feet 20 inch C. I. pipe	20,000 00
Cost of Disposal by using Contact Beds	$99,100 00
Interest and Sinking Fund at 5 per cent	$4,955 00
Maintenance estimated	2,000 00
Annual Cost of Operation	$6,955 00
Annual Per Capita Cost	.464

REMARKS.

The addition of contact beds possesses, we believe, one great advantage over intermittent filtration and sedimentation just previously estimated. The advantge is, we think, a more uniform effluent will be secured. The disposal plant will occupy less space. The treatment will, however, be more intense and require a little better superintendence. The contact material will require cleaning and washing iu a period of from 5 to 10 years, depending on the characteristics of the sewage and the works. This removal, washing and replacing costs from 30 to 50 cents per yard, assuming 40 cents, and the life of the beds as 10 years would give us the annual cost of washing the contact material at $80.00 per bed. We have designed 5 contact beds of which one will always stand idle. We believe this arrangement will materially prolong the life of the beds. Again, it will give the advantage of the material, while idle, of being exposed to the effects of the air, giving the voids complete aeration. Further, with a bed standing idle for a long term, the attendant can wash the contact material without conflicting with his routine duties.

FINAL LOCATION OF BEDS.

We wish it understood that while the locations chosen are believed to be the best, they need not be final. After the real estate is purchased and bids called for, we will stake out the final locations on the ground so that it may be viewed by prospective bidders.

PLAN (d) To pump the sewage from the point of primary collection on Ridgedale Avenue to a disposal works situated near the Town Limits.

A site for such disposal has been selected on or just outside the Town Limits and about 1,000 feet easterly from Ridgedale Avenue. This site will give any desired fall through the disposal works, necessitating, of course, the elevating of the sewage to the works from the point of primary collection by pumping.

The various stages in the process of purification with statue elevations, are shown graphically on Fig. II and are as follows:

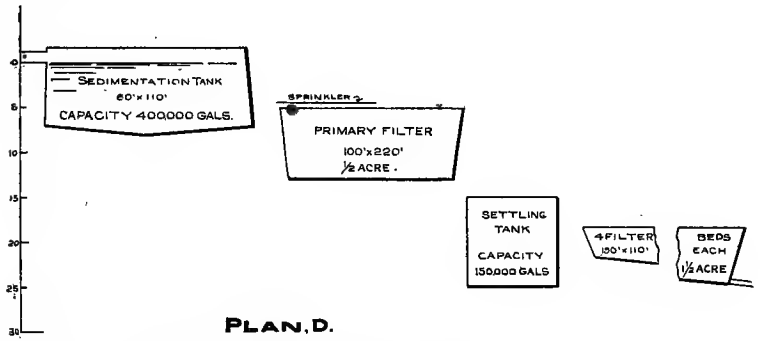


FIG. II. Ideal section showing profile through diposal plant, Plan D, with relative elevations.

The sewage passes through—

(1) the sedimentation tank from which it passes to
(2) sprinkling filters, and from this to
(3) a settling tank, and finally through
(4) sand filters.

The four steps embraced in this process are, in the light of present engineering knowledge of the subject of sewage disposal, supposed to give the highest practicable degree of purification attainable. After considerable experimentation, such a scheme was recommended for Columbus, Ohio, and also later recommended for Baltimore, Md. By this process we substitute the sprinkling filters, settling tank and sand filters for the intermittent sand filters outlined in paragraph (c) Second Study. These filters require 6 acres. Owing to the preliminary treatment and the consequent removal of such suspended matter, we could run the sand filters at a higher rate than 150,000 gallons per acre per day. We have estimated 650,000 gallons per acre per day, which would require approximately 1½ acres; the settling tank would need to be a 150,000 gallon tank, uncovered, and the sprinkling filters give good results at the rate of 2,000,000 gallons per acre per day, which would call for ½ acre of sprinkling filters.

COSTS.

Basing our estimates on these figures this method of disposal, exclusive of real estate, amounts to the following:

Estimated Cost of Disposal Plant.

Sedimentation Tank, Buildings and Machinery	$ 9,000 00
Settling Tank, ½ acre	18,000 00
Sprinkling Filters	30,000 00

Sand Filters, 1½ acres at $5,000		7,500 00
		$64,500 00

Estimated Cost of Pumping.

Pumps, Engines, Dynamos and Machinery	$10,000 00	
Addition for Pump Use	2,000 00	
Pump Well	1,200 00	
Chimney	1,100 00	
Receiving Basin	800 00	
	$15,100 00	
Total cost of Disposal by Pumping	$79,600 00	

Operation.

$79,600.00 at 5 per cent	$3,980 00	
Maintenance	3,000 00	
Annual Cost of Disposal	$6,980 00	
Less Electricity furnished Ejectors	300 00	
Net Annual Cost of Disposal	$6,680 00	
Annual Cost per capita	0.445	

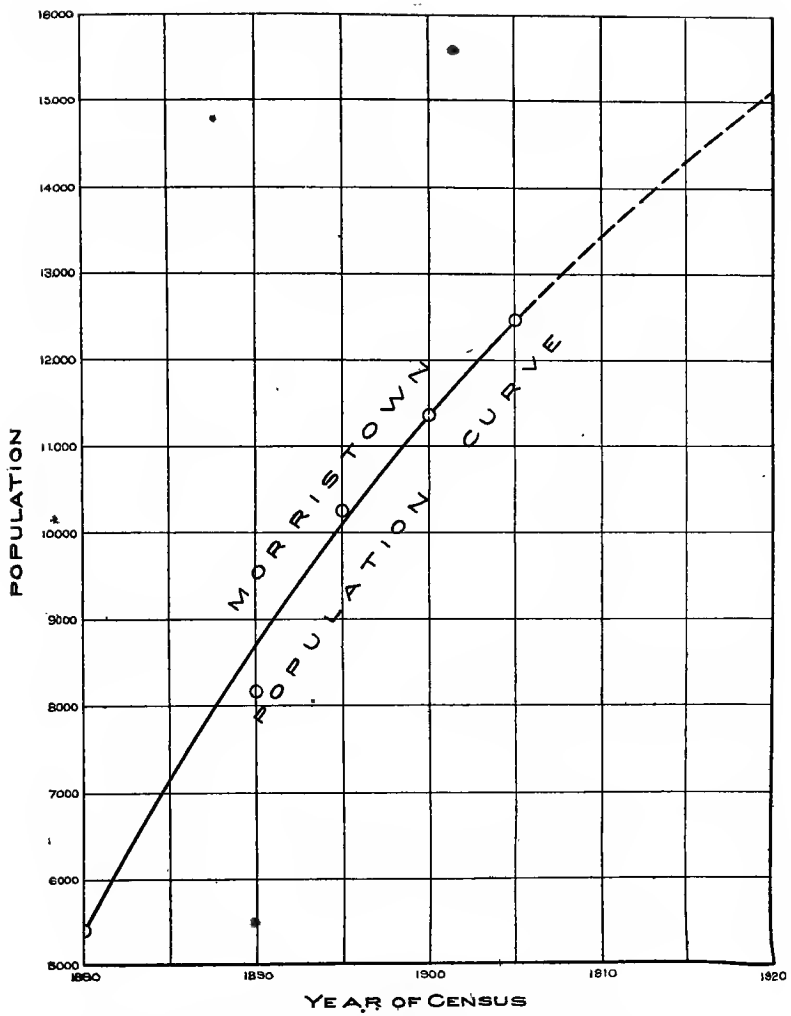


FIG. III. FUTURE POPULATION.

Per capita costs are based on the future estimated population of 15,000 in 1920, for which our designs are made. The increase in population in Morristown since 1880 has been about as follows:

1880, 5,418; 1890, 8,156; 1895, 10,290; 1900, 11,267; 1905 ,12,356

This increase is shown graphically in Fig. III as is also the probable increase, which leads us to believe that the population will be about 15,000 in 1920, conditions remaining normal.

MINUTIÆ OF THIRD STUDY.

METHODS OF DISPOSAL.

PLAN, So much has been said in the body of the Report preceding on the subject of sewage disposal, that no further elaboration will be made here.

Generally speaking, there are three ways of disposing of sewage aside from disposal by dilution, namely—

PLAN (a) disposal on artificial beds,

PLAN (b) disposal on natural beds, and

PLAN (c) disposal by chemical precipitation.

PLAN (a) Disposal on artificial beds received our consideration for we early found that this method *alone was practicable* for Morristown.

PLAN (b) To use this method presupposes the location of a natural sand bed of the proper texture, answering the following specifications:

First—Location convenient to the point of proposed outfall.

Second—At the proper elevation to receive the sewage by gravity or by pumping, the pumping, to be at a lower cost of maintenance than the interest and sinking fund charges on the first cost of artificial beds.

Third—Overlaid with so little top soil as to facilitate its ready conversion into sewage beds.

No natural beds answering to the above specifications were found.

PLAN (c) Disposal by chemical precipitation is applicable mainly to sewage containing chemicals and industrial wastes. It is not suitable nor justified for domestic sewage of such a quality as that at Morristown, and was eliminated from consideration by its high cost of maintenance and the extreme care required in its operation. These considerations would reject chemical precipitation in many localities, but for Morristown, especially where a high and uniform degree of purification is required, we believe it to be wholly impracticable.

TABULATION

Street	From	To	Cut in Feet	Size	Liueal Feet	M.H.	F.T.	I P. Cost
Chestnut	M. H.	Cherry	7	8"	555		1	
Cherry	Chestnut	M. H.	8	8"	248	1		
"	M. H.	M. H.	8	8"	175	1		
"	M. H.	Western	7	8"	65	1		
Plum	M. H.	"	7	8"	260		1	
Western	M. H.	M. H.	8	8"	270		1	
"	M. H.	M. H.	8	8"	275	1		
"	M. H.	Plum	8	8"	645	2		
"	Plum	M. H.	7	8"	125	1		
"	M. H.	M. H.	7	8"	275	1		
"	M. H.	Searing	8	8"	355	1		
Prt. Way	M. H.	Cherry	6	8"	550		1	
Searing	Western	M. H.	8	8"	200	1		
Prt. Way	Searing	M. H.	8	8"	400	1		
"	M. H.	M. H.	8	8"	400	1		
"	M. H.	Miller St.	8	8"	325	1		
"	M. H.	M. H.	7	8"	475		1.2	
"	M. H.	Miller St.	7	8"	475	1		
Miller St.	M. H.	M. H.	7	8"	173		1	
"	M. H.	Phoenix	7	8"	165	1		
"	Phoenix	M. H. Bend	8	8"	80	1		
"	Budd	M. H. Bend	7	8"	"375	1		
Budd	M. H.	Miller St.	7	8"	"400		1	
"	M. H.	M. H.	8	8"	"385		1	
"	M. H.	Miller St.	7.5	8"	380	1		
Phoenix	M. H.	M. H.	8.5	8"	400		1-2	
"	M. H.	Miller St.	8	8"	345	1		
Prt. Way	M. H.	M. H.	8	8"	310	1		
"	M. H.	M. H.	8	8"	310	1		
"	M. H.	M. H.	8	8"	325	1		
Mills	M. H.	M. H.	6	8"	300	1	1	
"	M. H.	M. H.	7.13	8"	440	1		
"	M. H.	Kenmuir	15	8"	450	1		
"	Kenmuir	M. H.	10.5	8"	200	1		
"	M. H.	Hazelett	7	8"	315	1		
"	Hazelett	Earley	7.5	8"	245	1		
"	Earley	M.H.	7	10"	195	1		
"	M. H.	Wash'n St.	3-16	10"	510	1		24'
Earley	M. H.	Harrison	8	8"	490		1	
"	Harrison	M. H.	8	8"	300	1		
"	M. H.	Mills	6	10"	320	1		12'
Milton	M. H.	Hazelett	7	8"	410			

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P. Cost
Hazelett	Milton	M. H.	8	8"	300	1		
"	M. H.	Mills	8	8"	300	1		
Kenmuir	M. H.	Mills	3-13	8"	555		1	
Sussex	Cutler	M. H.	8	8"	"235	1		
"	M. H.	Mills	8.5	8"	"280	1		
"	Mills	Soway	8.5	8"	345	1		
Mills	Cutler	Sussex	8	8"	"275		1	
Sussex	M. H.	Henry	10.5	8"	245	1		
"	Henry	Cleveland	13	8"	90	1		
"	M. H.	M. H.	8	8"	"335		1	
"	M. H.	Cutler St.	8	8"	"330	1		
Cutler St.	Sussex	M. H.	7	8"	275		1	
"	M. H.	M. H.	7	8"	165	1		
"	M. H.	Prt. Way	8	8"	290	1		
"	M. H.	Prt. Way	8	8"	395		1	
Prt. Way	Cutler	Spdwell Pl	8	8"	340	1		
Spdwll Pl.	Spdwll Av.	Prt. Way	8.5	8"	430		1	
"	Sussex	M. H.	7	8"	225		1	
"	M. H.	Prt. Way	8	8"	170	1		
Prt. Way	Spdwll Pl.	Sussex	8	8"	270	1		
Henry	M. H.	Sussex	8	8"	315		1-2	
"	M. H.	Spdwll Av	8	8"	250		1-2	
Clvlnd	Sussex	Bend	12	8"	385	1		
"	Bend	Bend	12.5	8"	40	1		
"	Bend	Grand	13"	8"	240	1		
Grant	M. H.	M. H.	7	8"	215		1	
"	M. H.	Clev'nd	8	8"	230	1		
"	Clev'nd	Blvw Ter.	14	8"	75	1		
"	Blvw. Ter.	M. H.	17-8	8"	175	1		
"	M. H.	Harrison	8	8"	125	1		
Harrison	M. H.	Grand	7	8"	400		1	
"	Grant	Morton	6.5	8"	310	1		
"	Morton	Earley	5-15	10"	370	1		
Columbia	Sussex	M. H.	8	8"	320		1	
"	M. H.	Belvw. Ter.	7-14	8"	320	1		
Belvw. Ter.	Morton	Columbia	7	8"	190		1	
"	Columbia	Grant	16	8"	250	1		
Morton	M. H.	Harrison	7	8"	375		1	
Ann	M. H.	Western	8	8"	150		1-2	
Western	Ann	M. H.	7.5	8"	200	1		
"	M. H.	Wash'ton	7	8"	365	1		
Phoenix	M. S.	M. H.	8	8"	475		1-2	
"	M. H.	Wash'ton	8	8"	110	1		
Prt. Way	M. H.	Bend	7	8"	270		1-2	
"	Bend	Phoenix	8	8"	165	1		
Cobb	M. H.	M. H.	7	8"	355		1	
"	M. H.	Wash'ton	9	8"	355	1		
Washington	Western	M. H.	8	8"	130		1	
"	M. H.	Phoenix	8	8"	350	1		
"	Phoenix	M. H.	8	8"	220	1		
"	M. H.	Cobb	8	8"	495	1		

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	L.P.	Cost
Washington	Cobb	Prt. Way	8	8"	215	1			
Prt. Way	Wash'ton	M. H.	8	15"	365	1			
"	M. H.	M. H.	8	15"	400	1			
"	M. H.	Atno	7	15"	405	1			
Washington	M. H.	Westwood	4	8"	570	1	1		12'
"	W. Wood	Mills	5-13	8"	425	1			
"	Mills	Budd	15	10"	235	1			
"	Budd	Prt. Way	11	10"	395	1			
Prospect	M. H.	M. H.	6	8"	295		1-2		
"	M. H.	Clinton	6	8"	65	1			
Clinton	Prospect	M. H.	6	8"	250		1		
"	M. H.	Atno	6	8"	290	1			
Atno	Wash'ton	Clinton	7	8"	230		1		
"	Clinton	Prt. Way	7	8"	140	1			
"	Earley	M. H.	7	8"	230		1		
"	M. H.	Siphon	8	8"	405	1			
Earley	Atno	Prt. Way	9	8"	425	1			
"	Speedwell	M. H.	6	8"	220		1		
"	M. H.	Prt. Way	5	8"	135	1			
Prt. Way	Earley	Prt. Way	7	8"	370	1			36
Sussex	Cleveland	M. H.	8	8"	472		1		
"	M. H.	Spdwell	8	8"	330	1			
Speedwell	M. H.	Bend	7	8"	300		1		
"	Bend	Cutler	7.5	8"	365	1			
"	Cutler	Spdwll Pl	10	8"	340	1			
"	Spdwll Pl	Henry	9	8"	365	1			
"	Henry	M. H.	8	8"	350	1			
"	M. H.	M. H.	8.5	8"	350	1			
"	M. H.	M. H.	9	8"	390	1			
"	M. H.	Spring	8.5	8"	350	1			
"	Spring	Clintn Pl.	10	8"	220	1			
"	M. H.	Clintn Pl.	9	8"	555		1		
Henry	M. H.	Spdwll	8	8"	250		1-2		
Prospect	M. H.	High	8	8"	305		1-2		
High	M. H.	Prospect	8	8"	170		1-2		
"	Prospect	Spdwell	7	8"	235	1			
Speedwell	High	M. H.	8	8"	375	1			
"	M. H.	Water	8	8"	40	1			
Park Pl. N	Wash'ton	Speedwell	12	8"	475		1		
Water	Spdwell	M. H.	8	8"	225	1			
"	M. H.	M. H.	7	8"	240	1			
"	M. H.	Bend	5	8"	160	1			12'
"	Bend	Spring	5	8"	185	1			
Spring Pl.	M. H.	Spring St.	8	8"	340		1		
Spring St.	Morris St	Spring Pl.	8	8"	70		1		
"	Spring Pl	M. H.	8	8"	465	1			12'
"	M. H.	Centre	4	8"	165	1			
"	Spdwell	M. H.	9	8"	175	1			
"	M. H.	Main	8	8"	370	1			
"	Main	Water	7	15"	170	1			
	Water	Centre	7.5	15"	315	1			

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P.	Cost
Flagler	Spdwell	Bend	7	8"	160		1		
"	M. H.	Race	6	8"	575	1			
"	Race	Bend	7	12"	215	1			
"	Bend	Water	6	15"	185	1			
Water	M. H.	Mt. Airy	7	8"	65		1		
"	Mt. Airy	Bend	7	8"	200	1			
"	Bend	Willow	7	8"	295	1			
"	Willow	Bend	7	8"	330	1			
"	Bend	Cole	7	8"	100	1			
"	M. H	Flagler	6	8"	330	1	1		
Linden	M. H.	Grove	8	8"	407		1		
Grove	Linden	Willow	8	8"	180	1			
"	M. H.	M. H.	8	8"	*170		1		
"	M. H.	M. H.	9	8"	* 50	1			
"	M. H.	Linden	9	8"	* 60	1			
Willow	Grove	M. H.	4-9	8"	400	1			
"	M. H.	M. H.	11	8"	415	1			
"	M. H.	Water	8	8"	200	1			
Liberty	Hazel	Linden	8	8"	350	1			
"	Linden	Mt. Airy	8	8"	290		1		
Mt. Airy	Liberty	M. H.	9	8"	175		1		
"	M. H.	Water	8	8"	175	1			
Jersey	M. H.	M. H.	6	8"	*260		1		
"	M. H.	M. H.	6	8"	*300	1			
"	M. H.	Water	7	8"	*300	1			
Water	Jersey	Monroe	8	8"	*125	1			
"	Monroe	Hillary	9	8"	330	1			
"	Hillary	Hazel	8.5	8"	400	1			
"	Hillary	Garden	8.5	8"	200	1			
"	Garden	Linden	9	8"	150	1			
"	Linden	Abbett	8.5	8"	250	1			
Hillary	M. H.	M. H.	8	8"	295		1		
"	M. H.	M. H.	9	8"	300	1			
"	M. H.	M. H.	8	8"	300	1			
Hazel	M. H.	Liberty	8	8"	350		1		
"	Liberty	Water	9	8"	350	1			
Linden	M. H.	Water	9	8"	275		1		
Abbett	Water	M. H.	9	8"	278	1			
"	M. H.	Lincoln	8	8"	276	1			
Abbett	Lincoln	M. H.	7.5	8"	258	1			
"	M. H.	Siphon	7.5	8"	265	2			
Ann	M H.	Court	7.5	8"	200		1-2		
Court	M. H.	Ann	9	8"	280		1		
"	Ann	M. H.	8.5	8"	220	1			
"	M. H.	South	8.5	8"	300	1			
High	M. H.	Wash'tn	8	8"	360		1-2		
Market	M. H	South	7-12	8"	290		1		
South	Miller Rd	Pine	15	10"	300	1			
Pine	South	King	14-6	10"	445	1			
"	King	M. H.	7	10"	300	1			
"	M. H.	M. H.	8	10"	260	1			12'

Street	From	To	Cut in Feet	Size	Lineal Feet	M H.	F.T.	I.P.	Cost
Pine	M. H.	Mor. St.	8-15	10"	255	1			
King	M. H.	Pine	7.5	8"	315		1		
Garden	M. H.	M. H.	7	8"	*235		1		
"	M. H.	M. H.	6	8"	*175	1			
"	M. H.	M. H.	8	8"	*320	1			
"	M. H.	M. H.	8.5	8"	*320	1			
Prt. Way	M. H.	Abbett	7	8"	350	1			
Lincoln	M. H.	Fence	7.5	8"	475		1		
Prt. Way	Fence	Trunk	7.5	8"	420	1			
Abbett	Siphon	Olyphant	5	18"	300	1			
"	Olyphant	M. H.	6-9	18"	395	1			
"	M. H.	Ridgedle	9-14	18"	395	1			
Olyphant Pl	M. H.	M. H.	7	8"	180		1-2		
"	M. H.	M. H.	7	8"	185	1			
"	M. H.	M. H.	7	8"	305	1			
"	M. H.	Loop	7	8"	162	1			
"	Loop	Abbett	7	8"	130	1			
Loop	M. H.	M. H.	7	8"	355		1-2		
"	M. H.	M. H.	7	8"	115	1			
"	M. H.	M. H.	7.5	8"	175	1			
"	M. H.	Olphnt	8	8"	200	1			
Clinton Pl.	M. H.	Spdwell	8	8"	250		1		
Center	Spring	Siphon	6	15"	180				
"	Siphon	Cole	5	15"	430				
Cole	Water	Centre	7	15"	320				
Race	Prt. Way	M. H.	6-11	12"	340	1			
"	M. H.	Water	11-6	12"	400	1			
MacCulloch	Perry	Mil. Rd	8.5	8"	475	1			
"	Farragut	Mil. Rd	8	8"	490	1			
Perry	M. H.	M. H.	8	8"	240		1		
"	M. H.	MacCul'h	8	8"	240	1			
Miller Rd.	M. H.	"	8	8"	440		1		
Miller Rd.	MacCul'h	M. H.	9	10"	270	1			
"	M. H.	Maple	11-5	10"	270	1			
Boyken	Maple	M. H.	13-5	10"	250	1			
"	M. H.	South	16	10"	250	1			
DeHart	M. H.	South	9	8"	460		1		
Maple	DeHart	Oak	8	8"	365		1		
"	Oak	Boyken	9	8"	515	1			
South	High	Court	9.5	8"	45	1			
"	Court	M. H.	10	8"	685	2			
"	M. H.	DeHart	11	10"	500	1			
"	DeHart	M. H.	11	10"	340	1			
"	M. H.	Pine	10	10"	340	1			
"	M. H.	M. H.	8.5	8"	325		1		
"	M. H.	Madi. St.	9	8"	350	1			
"	M. H.	M. H.	8.5	8"	305		1		
"	M. H.	Madi. St.	8.5	8"	305	1			
Madi. St.	South	Elm	9.12	8"	235	1			
Elm	Madi. St.	M. H.	12-16	8"	310	1			
"	M. H.	M. H.	16-9	8"	310	1			

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P.	Cost
Elm	M. H.	Hill	7.5	8"	440	1			
"	Hill	Bend	8	8"	230	1			
"	Bend	M. H.	10	10"	195	1			
"	M. H.	Mor. St.	10	10"	41	1			
Hill	Frnklin Pl.	M. H.	8	8"	175		1		
"	M. H.	M. H.	8	8"	140	1			
"	M. H.	M. H.	8	8"	200	1			
"	M. H.	Elm	8	8"	400	1			
Park Pl. E	Park Pl N	Morris	11	8"	410		1		
Morris St	South	Park P E	10	8"	360		1		
"	Park P E	M. H.	10	8"	320	1			
"	M. H.	Spring St	9.5	8"	180	1			
"	Spring St.	M. H.	9	8"	300	1			
"	M. H.	M. H.	10	8"	300	1			
"	Pine	King	14	10"	275	1			
"	King	M. H.	13	10"	290	1			
"	M. H.	Olyphant	10.5	10"	290	1			48'
"	Olyphant	Ridgedale	9	10"	390	1			
"	Ridgedale	M. H.	7.5	10"	400	1			12'
King	Bend	M. H.	8	8"	265		1		
"	M. H.	M. H.	7.5	8"	300	1			
"	M. H.	Mor. St.	5-13	8"	300	1			
Lane	M. H.	Mor. St.	8	8"	460		1		48'
Olyphant Pl.	M. H.	Olypht	8	8"	145		1-2		
Olyphant	M. H.	Loop	8	8"	200		1-2		
"	Loop	M. H.	7	8"	312	1			
"	M. H.	Mor. St.	8	8"	300	1			
Ridgedale	M. H.	M. H.	8	8"	140		1-2		
"	M. H.	Mor. St.	9	8"	580	1			
Mor. St.	Wash'ton	Lafayette	8.5	8"	330	1			
"	Lafayette	M. H.	7	8"	400		1		
"	M. H.	M. H.	6	8"	200	1			
Mor. Av.	M. H.	M. H.	9.5	8"	350	1			
"	M. H.	M. H.	8	8"	350	1			
"	M. H.	M. H.	7.5	8"	700	2			
"	M. H.	Wash. Pl.	8	8"	355	1			
"	M. H.	Wash. Av.	8	8"	300		1		
Wash. Pl.	Mor. Av.	M. H.	8	8"	300	1			
"	M. H.	Bend	7	8"	300	1			
"	Bend	Bend	7	8"	150	1			
"	Bend	M. H.	7	8"	100	1			
Wash. Av.	M. H.	M. H.	8	8"	*540		1		
"	M. H.	M. H.	10.5	8"	350	1			
"	M. H.	M. H.	12.5	8"	400	1			
"	M. H.	M. H.	12	8"	350	1			
"	M. H.	M. H.	9.5	8"	350	1			
"	M. H.	M. H.	11	8"	240	1			
"	M. H.	M. H.	12	8"	400	1			
"	M. H.	M. H.	10	8"	400	1			
"	M. H.	M. H.	8	8"	290	1			
"	M. H.	Morris	8	8"	320	1			

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P.	Cost
Lafayette	Mor. Av.	M. H.	8	8"	385	1			
"	M. H.	Division	7	8"	400	1			
Division	M. H.	M. H.	7	8"	290	1			
"	M. H.	Lafayette	7	8"	230	1			
Headley Rd.	M. H.	South	13	10"	500		1		
South	M. H.	M. H.	6.5	8"	200		1		
"	M. H.	M. H.	10	8"	365	1			
"	M. H.	M. H.	13	8"	365	1			
"	M. H.	Headly	14	8"	400	1			
"	Headly	Mad Av.	14	8"	170	1			
"	M. H.	M. H.	10	8"	300		1		
"	M. H.	M. H.	10	8"	300	1			
"	M. H.	Mad. Av.	10	8"	300	1			
Mad. Av.	South	M. H.	15.8	10"	350	1			
"	M. H.	Frnk St.	8	10"	260	1			
"	Frnk	Jefferson	8	10"	450	1			
"	M. H.	M. H.	8	8"	200		1		
"	M. H.	M. H.	8	8"	325	1			
"	M. H.	Jefferson	8	8"	390	1			
"	M. H.	M. H.	8	8"	275		1		
"	M. H.	Prt. Way	7	8"	420	1			
"	M. H.	M. H.	8	8"	*350		1		
"	M. H.	M. H.	9	8"	350	1			
"	M. H.	DeKalb	8	8"	250	1			
"	DeKalb	M. H.	8	8"	350	1			
"	M. H.	Prt. Way	8	8"	350	1			
Jefferson	Mad. Av.	M. H.	7	10"	338	1			
"	M. H.	Prt. Way	8	10"	260	1			
"	Prt. Way	M. H.	7	10"	353	1			
Franklyn St.	Elm	M. H.	7.5	8"	440		1		
"	M. H.	Frkn Pl	8	8"	440	1			
"	Frnkn Pl.	Bend	8	8"	280	1			
"	Bend	M. H.	7	8"	190	1			
"	M. H.	DeKalb	8.5	8"	280	1			
"	M. H.	M. H.	8	8"	*225		1		
"	M. H.	M. H.	7.5	8"	*270	1			
"	M. H.	M. H.	7.5	8"	*260	1			
"	M. H.	M. H.	7.5	8"	*235	1			
"	M. H.	DeKalb	9	8"	* 30	1			
Franklyn Pl.	M. H.	Frkn Pl	8	8"	365		1-2		
"	M. H.	Hill	8	8"	345		1-2		
DeKalb	Frnkn St.	M. H.	7	8"	*325	1			
"	M. H.	Jefferson	7	8"	*250	1			
"	Madison	Bend	8	8"	*320		1		
"	Bend	M. H.	9	8"	*365	1			
"	M. H.	Prt. Rd.	9	8"	*350	1			
"	Prt. Rd.	M. H.	8	8"	*340	1			
"	M. H.	M. H.	7	8"	*300	1			
"	M. H.	M. H.	6	8"	350	1			
"	M. H.	Jefferson	7	8"	350	1			
Hill	Frnkn Pl.	M. H.	8	8"	287	1			

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P.	Cost
Hill	M. H.	Ford	8	8"	275	1			
Ford	Frkln Pl.	M. H.	6.5	8"	*270		1		
Ford	M. H.	Hill	6-12	8"	*310	1			12'
Ford	M. H.	Hill	6-12	8"	*295		1		
"	M. H.	Howells	8.5	8"	180		1		
"	M. H.	M. H.	7	8"	110		1		
"	M. H.	Howells	8	8"	195	1			12'
Ridgedale	M. H.	M. H.	7.5	8"	385		1-2		
"	M. H.	Abbett	7.5	8"	300	1			
"	Abbett	M. H.	14-5	20"	400	1			
"	M. H.	M. H.	5	20"	285	1			
"	M. H.	Siphon	7	20"	400	1			
Prt. Way	Mor. St.	M. H.	6	15"	300	1			
"	M. H.	M. H.	6	15"	350	1			
"	M. H.	M. H.	6	15"	330	1			
"	M. H.	M. H.	6	15"	130	1			
"	M. H.	M. H.	6	15"	200	1			
"	M. H.	M. H.	6	15"	320	1			12'
"	Division	Prt. Way	6	8"	100	1			
Water St.	Flagler	Siphon	7	15"	180	1			12'

INVERTED SIPHONS.

Water St.	M. H.	Cole	1	8"	130	2			
			1	6"					
Centre	M. H.	M. H.	1	8"	100	2			
			1	10"					
Abbett	M. H.	M. H.	1	8"	135	2			
			1	10"					
Atno	M. H.	Prt. Way	2	6"	451	2			
Ridgedale Av.	M. H.	Prt. Way	2	6"	120	2			
Spdwell Av.	M. H.	Bend	8	8"	*390		1		
"	Bend	M. H.	8	8"	*315	1			
"	M. H.	Bend	8	8"	*352	1			
"	Bend	M. H.	8	8"	*300	1			
"	M. H.	M. H.	8	8"	*400	1			
"	M. H.	Emmet	4	8"	*200	1			
"	Emmet	Prt. Way	5	8"	*172	1			
Hill	DeKalb	Bend	7	8"	*120		1		
"	Bend	M. H.	8	8"	*150	1			
"	M. H.	M. H.	7	8"	*400	1			
"	M. H.	Jefferson	6	8"	*400	1			
Columbia Rd.	M. H.	Morris	7	8"	*300		1		
Olmstead Rd.	M. H.	M. H.	6	8"	*440		1		
"	M. H.	Washt'n	7	8"	*440	1			
Malcolm	M. H.	M. H.	8	8"	*170	1			
"	M. H.	Trk Line	5	8"	* 20	1			
"	F. T.	Ridgedale	6	8"	*300		1		36'
Ridgedale	Siphon	Siphon	7	8"	*165		1		36'
Morris Av.	F. T.	Fork	7	8"	*250		1		
Woodland	F. T.	South	8	8"	*200		1		

Street	From	To	Cutiu Feet	Size	Li.eal Feet	M.H.	F.T.	I.P.	Cost
Rt. Way	W'dlnd	South	8	8"	*200	1			
*Market	M. H.	Doughty	8	8"	545		1		
"	Doughty	M. H.	8	8"	340	1			
"	M. H.	Colles	9	8"	355	1			
"	M. H.	M. H.	8	8"	*510		1		
"	M. H.	M. H.	7	8"	*170	1			
"	M. H.	Maple	9.5	8"	250		1		
"	Maple	M. H.	8	8"	215	1			
"	M. H.	Bank	12	8"	155	1			12'
"	Bank	Mac	9	8"	140	1			
"	Mac.	M. H.	9	8"	195	1			
"	M. H.	Colles	10-15	8"	335	1			
Colles	Mt. Kemble	Wetmore	14-6	8'	310	1			12'
"	Farragut	Wetmore	8.5	8"	440	1			
Bank	M. H.	Bend	9	8"	188		1		
"	Bend	Ann	8.5	8"	283	1			
"	Ann	Market	9	8"	430	1			12'
MacCull.	M. H.	DeHart	8	8"	370		1		
"	M. H.	M. H.	7.5	8"	190		1		
"	M. H.	Market	8	8"	160	1			12'
Wetmore	M. H.	Mac.	8	8"	408		1		
"	Mac.	Colles	9	8"	523	1			
"	Colles	M. H.	9	8"	320	1			
"	M. H.	Ogden	7.5	8"	320	1			
"	Ogden	M. H.	8	8"	325	1			
"	M. H.	Pump	8	8"	330	1			
"	Prt. Way	M. H.	8	8"	235	1			
"	M. H.	Pump	8	8"	275	1			12'
Prt. Way	Mt. Kemble	Wetmore	8	8"	*330	1			
Miller Rd.	M. H.	M. H.	8	8"	250		1		
"	M. H.	Ogden	8	8"	280	1			
Maple	M. H.	Market	8.5	8"	390		1		
Doughty	M. H.	M. H.	8	8"	132		1		
"	M. H.	Wetmore	8	8"	125	1			
Ogden	Miller Rd.	M. H.	7.5	8"	100	1			
"	M. H.	M. H.	8	8"	100	1			
"	M. H.	M. H.	8	8"	130	1			
"	M. H.	M. H.	7.5	8"	110	1			
"	M. H.	Wetmore	7	8"	335	1			
Ann	M. H.	M. H.	8	8"	360		1		
"	M. H.	Bank	7.5	8"	140	1			
Colles	Miller	M. H.	6	8"	*215		1		
"	Farragut	M. H.	6	8"	*160		1		
Prt. Way	Colles	M. H.	7	8"	*300	1			
"	M. H.	Ogden	8	8"	*300	1			
*James	South	Maple	8	8"	310		1		
"	Maple	M. H.	7	8"	305	1			
"	M. H.	Mac.	7	8"	290	1			
"	Mac.	M. H.	7.5	8"	225	1			
"	M. H.	Green	7.5	8"	240	1			

*Pumping Station No. 1.

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P	Cost
*James	Green	Bend	8	8"	120	1			
"	M. H.	M. H.	8	8"	*385	1			
"	M. H.	M. H.	8	8"	*250	1			
"	M. H.	M. H.	7	8"	*305	1			
"	M. H.	M. H.	7.5	8"	*310	1			
"	M. H.	Pump	8	8"	*305	1			
"	F. T.	Bend	7	8"	*440		1		
"	Bend	M. H.	7	8"	*245	1			
"	M. H.	Bend	7	8"	*300	1			
"	M. H.	Pump	7.5	8"	*120	1			12'
Madison	M. H.	Mac.	8	8"	325		1		
"	Mac.	M. H.	7	8"	270	1			
"	M. H.	Green	7	8"	275	1			
MacCulloch	M. H.	Mad. St.	7	8"	270	1	1		
"	M. H.	James	8	8"	360	1	1		
Maple	M. H.	James	8	8"	340		1		
Green	Madison	James	8	8"	405	1			
*South St.	F. T.	M. H.	8	8"	390		1		

*Pumping Station No. 2.

13 8"	330 1		"		M. H.			Woodlwn
"	Woodlwn	Walnut	10	8"	200	1		
"	Walnut	Pump	8	8"	120	1		
Prt. Way	F. T.	M. H.	8	8"	400		1	
"	M. H.	M. H.	8	8"	300	1		
"	M. H.	M. H.	8	8"	400	1		
"	M. H.	M. H.	8	8"	400	1		
"	South	South St.	8	8"	330	1		
:Emmet Ave.	M. H.	M. H.	8	8"	*400		1	
"	M. H.	M. H.	8	8"	*285	1		
"	M. H.	Bend	8	8"	*155	1		
"	Bend	Bend	8	8"	*140	1		
"	Bend	M. H.	8	8"	*235	1		
"	M. H.	M. H.	8	8"	*170	1		12'
"	M. H.	Pump	10	8"	*365	1		
Prt. Way	Madison	Bend	7	8"	365	1		
"	Bend	M. H.	7	8"	300	1		
"	M. H.	M. H.	7	8"	360	1		
"	M. H.	M. H.	7	8"	400	1		
"	M. H.	Jefferson	7	8"	370	1		
"	DeKalb	M. H.	7.5	15"	255	1		
"	M. H.	Bend	7.5	15"	280	1		
"	Bend	Bend	8	15"	230	1		
"	Bend	Track	8	15"	400	1		
"	Track	Howells	10	15"	360	1		
"	Howells	Ford	11	15"	440	1		
"	Ford	Trunk	7	8"	450	1		
"	Ford	M. H.	9	15"	450	1		
"	M. H.	Morris	9	15"	100	1		

*Pumping Station No. 3.
:Pumping Station No. 4.

Street	From	To	Cut in Feet	Size	Lineal Feet	M.H.	F.T.	I.P.	Cost
Prt. Way	Atno	M. H.	7	15"	135	1			
"	M. H.	M. H.	7	15"	280	1			
"	M. H.	M. H.	7	15"	200	1			
"	M. H.	M. H.	7	15"	355	1			
"	M. H.	M. H.	7	15"	250	1			250'
"	M. H.	M. H.	8	15"	180	1			
"	M. H.	Spring	10	15"	180	1			
"	Centre	R. R.	7	18"	380	1			
"	R. R.	M. H.	7	18"	400	1			144'
"	M. H.	M. H.	8	18"	400	1			
"	M. H.	Abbett	7	18"	400	1			
"	Spdwell	M. H.	8	12"	* 35	1			
"	M. H.	M. H.	6	12"	*220	1			
"	M. H.	M. H.	6	12	*260	1			
"	M. H.	M. H.	6	12"	*410	1			
"	M. H.	M. H.	6	12"	*280	1			
"	M. H.	M. H.	6	12"	*340	1			
"	M. H.	M. H.	6	12"	*410	1			
"	M. H.	M. H.	6	12"	*400	1			
"	M. H.	M. H.	6	12"	*400	1			
"	M. H.	M. H.	6	12"	*400	1			
"	M. H.	Race	6	12"	*375	1			
Kinney	M. H.	Anderson	7	8"	*190		1		
Thompson	M. H.	Anderson	7	8"	*225		1		
Anderson	Thompson	Kinney	7	8"	*400	1			
Prt. Way	Anderson	Trunk	7	8"	* 60	1			
Spdwell Av.	M. H.	M. H.	6	8"	*380		1		
"	M. H.	Bend	7	8"	*365	1			
"	Bend	M. H.	7	8"	*350	1			
"	M. H.	Prt. Way	7	8"	*240	1			

TABULATION OF COST OF COLLECTION AND DISPOSAL

IN

DOLLARS PER CAPITA

DISPOSAL	COLLECTION			
	Gravity to Arthur Kill	Sed'n Tanks and Sand Filters	Sed'n Tanks, Contact Beds and Sand Filters	Pumping to Disposal
Sewering by Gravity	1.733	0.574	0.605	0.586
Sewering with Ejectors	1.655	0.493	0.480	0.508

DOLLARS

Sewering by Gravity	$583,612 50	$142,862 50	$151.962 50	$132,462 50
Sewering with Ejectors	540,850 00	100,100 00	109,200 00	89,700 00

Cost of Sewers for Entire Town	$174,449 95
Dollars Per Capita	11.630
Annual Cost Per Capita	.582

TABULATION OF DISPOSAL COST, SEWERS NOT INCLUDED.

Collection of West Side of Town to Disposal.

STUDY I	METHOD	First Cost	Annual Cost	Annual Cost Per Capita
Plan a	Sewering by Gravity	$52,862 50	$2,114,50	0.141
Plan b	Sewering with Ejectors	10,100 00	943 00	0.063
Plan c	Sewering with Two Disposal Plants	Not considered	Not considered	Not considered

Disposal for Entire Town

STUDY II	METHOD			
Plan a	By Gravity to Whippany River	Nil	Nil	Nil
Plan b	By Gravity to Arthur Kill	$530,750 00	23,883 75	1.592
Plan c	By Gravity to Sed. Tank and Sand Filters	90,000 00	6,500 00	0.433
Plan c'	By Gravity to Sed. Tank, Contact Beds and Sand Filters	99,100 00	6,955 00	0.464
Plan d	By Pumping to Disposal Works	79,600 00	6,680 00	0.445

ESTIMATED COST OF SEWERS.

DETAILED ESTIMATES PREPARED.

We have estimated the cost of the sewers exclusive of the ejectors, which are estimated elsewhere, and the results are set forth in the accompanying tables. The estimates are prepared so that each stretch of pipe is a unit and can be deducted from the total estimate if it is desired to omit any stretch. In the table the stretches which we recommend omitting are marked with a star (*) and the Map Plate I shows graphically the portion we would recommend building in 1907 as the first section. The table is subdivided, and that portion draining to the ejector chambers is classified separately. Our plans call for approximately the following amounts of work:

8	inch	Pipe	Sewers,	116,240	lineal	feet
10	"	"	"	10,201	"	"
12	"	"	"	4,485	"	"
15	"	"	"	3,405	"	"
18	"	"	"	3,740	"	"

Manholes,	342
Flushing Manholes,	126
Siphon Chambers,	10

In total, the plans call for 143,071 lineal feet of sewers of which 20,460 lineal feet cross private ways, as explained elsewhere. The estimates for sewers are based on costs of work under conditions similar to those at Morristown.

TOTAL AND PER CAPITA COST.

The estimated cost of sewering the Town completely, is $174,449.95. From the fact that Morristown has grown to its present size without sewers, public or private, it will be necessary to build at least 87.2 per cent. of the total to sewer the Town at all completely. Plate I shows the portions we recommend, and a glance at the Plate will show graphically the number of houses afforded sewer facilities by the portions recommended. The only portion omitted along which any number of people dwell, is the north end of Speedwell Avenue. This we omitted, thinking it was not justifiable to build it until local sanitary regulations were adopted and enforced. To sewer these houses would require a long expensive right of way.

The total cost of the portions we recommend to build in 1907, is $137,013.10. This gives a total cost of $9.134 per capita, or, an annual per capita cost of $0.457 for sewering.

COST OF SEWERING AND DISPOSAL.

Combining our cost for sewering and the cost of the ejectors, we have an annual cost of $0.52 per capita, which covers our recommended plans for the collection of the sewage. Using this

figure in connection with the different plans for disposal, we get the following total figures:

TOTAL COST OF RECOMMENDED SEWERS AND DISPOSAL (USING EJECTORS).

	Plan.	Total Cost of Portions Recommended.	Annual Per Capita Cost.
(b)	To Arthur Kill	$677,863 10	$2.112
(c)	By Gravity to Sedimentation Tanks and Sand Filters	237,113 10	.953
(c')	By Gravity to Sedimentation Tanks, Contact Beds and Sand Filters	246,213 10	.984
(d)	By Pumping to Disposal Plant	226,713 10	.965

TOTAL COST OF COMPLETE SEWERS AND DISPOSAL (USING EJECTORS).

(b)	To Arthur Kill	715,299 95	2.237
(c)	By Gravity	274,549 95	1.075
(c')	" "	283,649 95	1.062
(d)	By Pumping	264,149 95	1.090

RECOMMENDATIONS.

In view of the points brought out in the preceding Report, and review of our surveys, investigations and studies, we recommend—

I. That the sewage from the westerly portion of the Town be pumped over the ridge to the main system by ejectors.

II. That those portions of the sewers indicated by a star (*) in the detail estimate, be built at a later date than the first system.

III. Disposal by Plan c', by gravity to sedimentation tanks, contact beds and sand filters, as a proper method to give a high degree of purification.

IV. Disposal by Plan d, pumping to disposal works, as a proper alternate plan for disposal should the cost of securing property rights for Plan c' be disproportionately great, and

V. Proper and efficient care of the disposal works when built.

COST OF RECOMMENDED PLAN.

The cost of the recommended plan for the collection and disposal of the sewage of Morristown, is $246,213 10. To this must be added the expenses of the bond issue, procuring of rights of way, real estate for the disposal works, legal and miscellaneous expenses and the cost of engineering superintendence.

In closing, we wish to compliment the members of the Sewerage Commission for the deep interest they have shown in the subject of sewerage and the insight displayed in the intricate subject of sewage disposal. We also wish to extend our thanks to the members of your Honorable Body for the courtesies shown us.

Respectfully submitted,

WILLIAMS, PROCTOR & POTTS, Inc.

CLYDE POTTS, Vice-President.